THE BOYS' BOOK OF RAILWAYS

J R HOWDEN

THE BOYS' BOOK OF RAILWAYS

Down the Pacific Slope—Canadian Pacific Railway

IE BOYS' BOOK OF RAILWAYS

BY

J R. HO DEN

THOR OF " … BOOK … LOCOMOTIVES"

VER ONE HUNDRED ILLUSTRATIONS FROM PHOTOGRAPHS

NEW YORK
DERICK A. STOKES COMPANY
PUBLISHERS

THE BOYS' BOOK OF RAILWAYS

BY

J. R. HOWDEN

AUTHOR OF "THE BOYS' BOOK OF LOCOMOTIVES"

WITH OVER ONE HUNDRED ILLUSTRATIONS FROM PHOTOGRAPHS

NEW YORK
FREDERICK A. STOKES COMPANY
PUBLISHERS

FAS
August, 1910

PREFACE

THE last excursion upon which I had the enjoyment of playing the part of guide to my readers took us, in thought at least, upon the sea. In the present volume I invite them to come back again to dry land and the railway, with a view to our studying together a little further those principles and fascinating details of railway working whose fringe we just touched upon in the "Boys' Book of Locomotives." My thanks are due to those readers of my first two books who have been good enough to write to me about them. And I should like to add that it is always a great pleasure to hear from readers, especially those who want to ask questions. I must, however, ask them to forgive me if, in the exigencies of a fairly busy life, the answer be sometimes rather delayed.

As usual, too, I have a long string of obligations to acknowledge to those gentlemen and firms engaged in either actual railway work or in the construction of materials used by the railway companies, who have so kindly placed at my disposal information and pictures which have been utilised in the present volume. The following list, I think, includes all of those to whom the special indebtedness both of writer and readers is due.

J. E. Muhlfield, Esq., Baltimore & Ohio Railroad.

J. M. Gibbon, Esq., Canadian Pacific Railway.

F. H. Trevithick, Esq., Egyptian State Railway, Boulac, Cairo.

John G. Robinson, Esq., Great Central Railway, Gorton, Manchester.

H. A. Ivatt, Esq., Great Northern Railway, Doncaster.
A. L. Craig, Esq., Great Northern Railway, St. Paul, Minnesota.
J. C. Inglis, Esq., Great Western Railway, Paddington.
S. A. Pope, Esq., Great Western Railway, Paddington.
S. Dewar Holden, Esq., Great Eastern Railway, Stratford, Essex.
John C. Martin, Esq., Goodwin Car Company, New York.
F. B. Harriman, Esq., Illinois Central Railroad, Chicago.
William Renshaw, Esq., Illinois Central Railroad, Chicago.
John A. F. Aspinall, Esq., Lancashire & Yorkshire Railway.
Philip Skipworth, Esq., London & North Western Railway, Euston.
S. Warner, Esq., London & South Western Railway, Eastleigh, Hants.
W. Forbes, Esq., London, Brighton & South Coast Railway, London Bridge.
W. Worsdell, Esq., North Eastern Railway, Gateshead.
T. P. Fowler, Esq., New York, Ontario & Western Railway.
Geo. W. West, Esq., New York, Ontario & Western Railway, Middletown, New York.
Mons. L. Du Bousquet, Northern Railway of France, Paris.
W. P. Reid, Esq., North British Railway, Cowlairs, Glasgow.
A. W. Gibbs, Esq., Pennsylvania Railroad, Altoona.
Harry S. Wainwright, Esq., South Eastern & Chatham Railway, Ashford, Kent.
G. Mitchell, Esq., Vacuum Brake Company, London.

American Locomotive Company (Messrs. Davis & Lloyd).

The Barney & Smith Car Company, Dayton, Ohio.

Breslau Railway Wagon and Machine Company.

Browning Engineering Company, Cleveland, Ohio.

Baume & Marpent, Haine St. Pierre, Belgium.

British South Africa Company (Rhodesia Railways).

Compagnie Française de Matériel de Chemins de Fer. Ivry-port, near Paris.

Ganz & Co., Budapest.

Gloucester Railway, Carriage and Wagon Company, Ltd., Gloucester.

Hungarian Railway Carriage and Machine Works, Ltd., Gyor (Raab).

Internationl Sleeping Car & European Express Trains Company.

W. S. Laycock, Ltd., Sheffield.

Leeds Forge Company, Ltd., Leeds.

Midland Railway Company.

McKerrow & Co., London.

New York Central & Hudson River Railroad.

G. D. Peters & Co., Moorfields, London.

R. Y. Pickering & Co., Ltd., Wishaw, nr. Glasgow.

Pullman Car Company.

United Electric Car Co., Ltd., Preston, Lancashire.

Westinghouse Brake Company, London.

Two other points perhaps call for remark. There is apparent occasionally in some quarters a disposition to pour contempt on the "irresponsible scribblings of amateur engineers." Now I have to confess to coming under the category of these unfortunate people, but I should like to say in self-defence, that while I am quite ready to acknowledge that even amateurs may make mistakes, yet I think it should also be recognised that amateur criticism,

even of the high mysteries involved in railway operation, has not always been misplaced, and I do not think I am wrong in adducing the now kind and cordial recognition by railway authorities of an amateur institution like the Railway Club as evidence that British railway men, at least, recognise that such criticism is usually sincere and may occasionally be even valuable. This brings me to the second and last thing which I wanted to say in this preface. The head and front of the offence sometimes committed by amateur railwayists seems to have been the recognition that other countries present points of practice which even England might do well to imitate. In the following pages I have tried to arrive at a just estimate of the relative value of methods, not only English and American, but also European, so far as such a wide-reaching comparison could be attempted within the limits of a book like this. To the engrossing and perennially interesting subject of railway travel as it affects the traveller and the trader, and of what it means to the railway man himself, I have now to invite your attention.

CONTENTS

PART I.—PASSENGER

PART II.—FREIGHT

ILLUSTRATIONS.

THE BOYS' BOOK OF RAILWAYS

The Boys' Book of Railways

PART I—PASSENGER

I

HISTORICAL AND INTRODUCTORY

IN 1834, amid the stir and change of the early nineteenth century, Sir Robert Peel was hastily summoned from Rome to help his friend and colleague, the Duke of Wellington, in forming a ministry. Travelling with all speed, the journey of 1191 miles occupied a fortnight, an average of 85 miles a day. In September, 1907, *Bradshaw,* the great European time book for English-speaking travellers, gives the time for the same journey as forty-two and three-fourths hours. The means of transit which a great statesman had to make use of seventy years ago were precisely those which had, so far as we know, first been brought to perfection 2300 years earlier when the genius of the great Darius initiated and perfected a system of "royal roads" to bind his wide empire together. From the splendid capital, Susa, the Shushan of Scripture, the roads radiated, eastward into Persia proper and Carmania, northward toward the wilds of Scythia, westward, along the Euphrates valley into Asia Manor, while a south-going branch from this last led to Syria, Palestine and Egypt. Along their course, at convenient intervals, were established post-houses, where were stabled the fleet camels and horses for the us of the royal messengers. The speed of these travellers was only limited by the quality and endurance of man and

beast. The same remarks apply to the famous Roman roads, those great monuments of a civilisation whose effects and results are still traceable.

Among these I may just remind my readers of the Via Egnatia, which ran across Macedonia from sea to sea, linking the Adriatic at Dyrrachuim with the Ægean at Neapolis; the Via Claudia Augusta, which was completed under the Emperor Claudius about 50 A. D., and which passed over the Brenner Alps, thus joining Italy with the upper Danube; and lastly the famous Watling Street, which ran from Dover to Chester, through London. These are just three examples, taken almost at random, from the net work of broad and well-kept highways with which Rome interlaced her empire. Many of these highways still exist and are in use to-day: not better kept, scarcely perhaps, before the advent of the motor-car, so much frequented as in the days when they were rutted by the Roman biga or re-echoed the mail-clad march of the Roman legionaries.

In any case we must remember that the rate of travel, though of course considerably increased by the difference between a woodland path and a broad highway, was still measured by the power and speed of the animals used in transport. Moreover, as in the historic instance with which I opened this chapter, the use of animal transport was largely confined to the wealthy. Ordinary travellers had to trudge it on foot as best they might, and therefore, as we might well imagine, people stayed at home unless absolutely compelled to take a journey.

The first adaptation of animal transport to human needs was undoubtedly in the use of beasts of burden. These are still in constant employment, especially in the wilder parts of the earth, and range from the shaggy yak and mountain sheep of the Himalayas, or the ox and ele-

phant of the Indian plains, the camel of the deserts or the llama of the Andes, to the more usual donkey or mule or horse. The load carried varies much with the animal used and with the nature of the country across which the journey lies. A donkey's load is usually estimated at about one hundred pounds: a horse's or mule's at, say, two hundred pounds, and a camel's at from three hundred pounds to as much as one thousand pounds, according to breed, age and condition. Prior to the advent of railways the camel was in many parts of the world the only possible means of transport, owing to his or her unique power of long abstinence from water.

The next great step in advance came when the load was taken from the animal's back and carried upon some kind of vehicle. Animals can pull far more than they can carry: a horse in a light four-wheeled cart can draw as much as two and a half tons on a level road, or about twenty-eight times the load for the same animal on a pack-saddle. Considerations like these help us to understand how it was that men were willing to take so much trouble in building roads, so that nearly all the great civilisations of past ages have been famous as road-makers. When the Roman Empire broke up towards the end of the fifth century of our era, the magnificent paved roads, of which we have already spoken, began to fall into decay. This process of disintegration, alike in engineering and society, lasted for a dreary thousand years, until, about the time when the first streaks of the new day began to appear, most of them were little better than cart tracks, and many had become so bad as to be impassable for wheeled vehicles.

This period, accordingly, shows a gradual retrogression in the comforts of travelling. For passengers the litter, borne by mules or horses, behind and before, super-

seded the comfortable *carruca,* or four-wheeled covered travelling coach, and the roomy *rheda,* or char-a-banc, while the pack-saddle came back in place of the various kinds of "creaking plaustra," of which Virgil tells us. But, of course, even in these dark days, the wheeled carriage did not entirely disappear, and about the middle of the sixteenth century the upward movement became apparent also in this department of human activity, by the appearance of coaches in England, the first of which was perhaps brought from Holland. But coaches were not much good without roads to run on, and therefore little progress was made until about a century later when, in 1663, toll-gates began to be erected, the revenue from which was applied to mending the roads.

Another form of conveyance comes into sight about this time—the stage wagon, which, drawn by six or eight powerful horses, conveyed goods, in leisurely fashion, from town to town. Into these vehicles travellers, too poor to go by coach, began to crowd. My readers may reasonably look back upon these stage-wagons, and their older continental forerunners, as the prototype of the English third-class carriage, or American first-class car. About 1680 coaches began to run between London and the provincial towns, York, in the north, and Exeter in the west, being the limits of their trips. A "Flying-Coach" is especially mentioned as having run from London to Oxford in the day. The regular speed of the coaches varied from thirty miles per day in the winter, to fifty in the summer, while the fare was 2½d per mile.

The stage-coach passed to one further development a century later, when the first of the famous mail-coaches began to run in 1784. But these in England, and the "diligence" on the continent, were the last effort of the

old type of travelling to supply the world's needs. Twenty years after their inception the first steam locomotive was built and its shrill whistle sounded the doom of the old coaching days, with their discomfort and costliness. It is a curious and interesting fact that the marvellous developments of travel during the last hundred years have been away from the road, to which we yet seem to be coming back again to some extent, at least, in the adoption of the motor car. It is a fact not generally remembered that the first invention of the motor car was roughly contemporaneous with the invention of the railway locomotive, and that the true development of the old methods of transport is rather to be looked for in the motor car than in the railway train. The deeply interesting subject to which I invite the attention of my readers lies, as it were, a little apart, a system of its own, unique and unlike anything else in history. But it has seemed necessary to begin with this little sketch of the travel conditions of old times in order that we may the better appreciate the significance of the new method, to the consideration of which we will, if the reader pleases, now turn.

Two essentials differentiate between the travel of all history and the travel which began with the nineteenth century. The first is the use of rails, the second the use of steam. The earliest instance I have been able to discover of the use of a railway dates from the reign of Queen Elizabeth, when a few miles of wooden rails were laid down between coal-mine and wharf, in order that the horses might the more easily draw along the loaded wagons. The rail idea is really a variant of the ancient Roman plan of paving. But whereas the Romans paved the whole width of their roads, the paving in this Northumbrian example probably consisted of stout planks laid

down flush with the level of the road in two parallel lines along which the wheels of the wagons might more easily roll. Later the plan was conceived and executed of adding a low flange, or turned-up edge to the outer side of the planks in order to prevent the wagon wheels from leaving them. The next step was to elevate the planking an inch or two above the road level and make the flanges on the wheels instead of on the rail and we at once have a railway or railroad as we know it to-day.

When the rails can be made of iron with good joints a considerable increase becomes apparent in the efficiency of any vehicle placed upon them. My readers can readily estimate this increased efficiency by a comparison of the carrying powers of say a London 'bus and an ordinary pair-horse tram. Whereas the former can usually seat twenty-six passengers, the latter would, under similar conditions, have a seating capacity of thirty-six, an increase in the efficiency of the rail-borne vehicle over that of the ordinary road vehicle of nearly 39 per cent.

But in spite of this the greatly increased cost of a railway over a high road has practically never made it profitable to build the former so long as only animal traction was available. This of course does not apply to towns, where prior to the general introduction of electric traction many miles of horse tramways had been at work. Still, with very few exceptions, some of which will be referred to later, railways have not been built for horse haulage. The fact was that, about the same time at which the use of practicable iron rails began to direct attention to the new form of road, the steam locomotive likewise began to come to the front, and very soon monopolised the new method of transit. This was not, however, done without some struggle. The directors of

some of the earliest public railways in Great Britain were very divided upon the subject, and to take one instance, even when trains of coal wagons were being hauled over the Stockton & Darlington line by the locomotives, the same company's horse-drawn coach, the "Experiment," for some time continued its trips. But the issue could not long remain in doubt. In America, on the Baltimore & Ohio, as in Great Britain on the Stockton & Darlington, and other early lines, the horse was quite evidently beaten, and, to quote from one of the arguments of the day, the breed of horses appeared to have been already improved to its utmost capacity, while no man living could tell to what degree of excellence the breed of locomotives might arrive.

It may be of interest just here to record that the first public passenger train in the world ran in September, 1825, on the opening of the line from West Auckland, via Stockton, to Darlington. It consisted mostly of coal wagons, but carried four hundred and fifty passengers, The engine was the famous "Locomotion," now mounted on a stone pedestal at Darlington Bank Top Station, North Eastern Railway. The first passenger line in America was built in 1829 by the Delaware & Hudson Canal Company. The first passenger train was experimented with near Honesdale, Pa., and was drawn by an engine called the "Stourbridge Lion," which had been imported from England. In the same year took place the celebrated Rainhill contest, on the railway then approaching completion between Manchester and Liverpool. In 1830 this line was opened for traffic, and, in the same year, the first section of the Baltimore & Ohio; this only extended to Ellicott's Mills, a point fifteen miles from Baltimore. This latter road was worked by horses for nearly two years, a fact perpetuated in the station still

called Relay House. The early time-tables of this company did not speak of "trains," but of "brigades of cars."

The form of vehicle used on both sides of the Atlantic in these early years of the railway was closely modelled on the old stage- or mail-coaches. Not only the pattern, but much of the nomenclature of the coaching days was taken over by the new method of transit. The passenger vehicles were still "coaches," the compartments in a locomotive round-house, when such began to be built, received the name of "stalls." In Great Britain, too, the vehicle for transport of goods was still a "wagon," while the duties, and, to some extent, the personalities, of "driver" and "guard" were readily transferred from the old to the new. But, to go back, after this digression, to the form of carriage; the earliest consisted of one compartment with seats outside at either end, and a space between them, in the centre of the roof, for passengers' baggage. The next step taken—it is not, perhaps, possible to say just when—was to build a carriage consisting of two or three of the old coach-bodies, still retaining the outside seats. A copy of a ticket which is before me as I write, and which was issued in 1838 by the New York & Harlem Railroad, now part of the New York Central, shows a picture of a carriage such as this on its obverse. Before very long the increasing speed of trains rendered the outside seats practically useless. To be enwreathed in clouds of smoke, to have one's eyes, nose, ears, and clothing filled with coal dust, and, finally, to be nearly jolted or blown from one's airy perch, soon proved too much for even the most intrepid traveller. The outside seats accordingly were removed, though for long the practice was continued of carrying luggage on the coach roof, and even to this day old carriages may sometimes

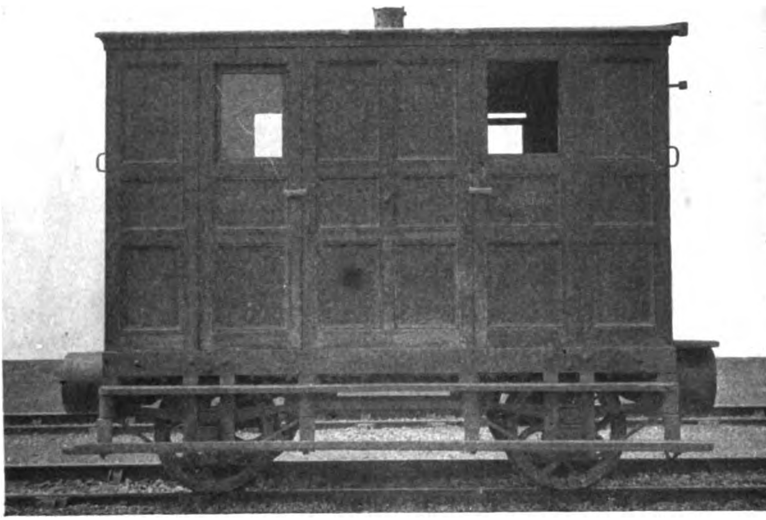

FIG. 1.

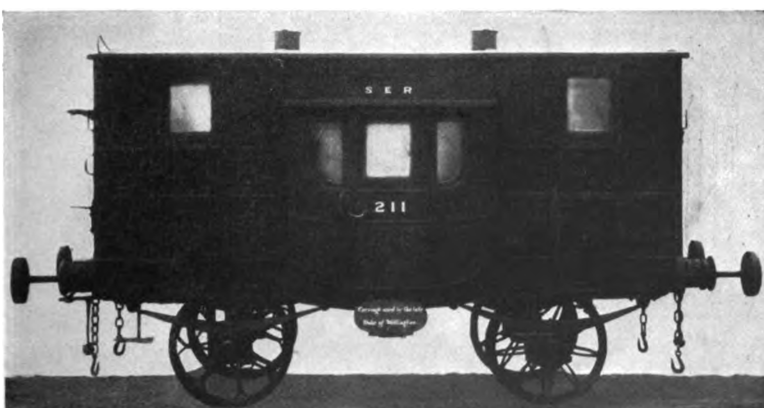

FIG. 2.

TWO MORE SPECIMENS OF EARLY RAILWAY CARRIAGE BUILDING.

FIG. 1. SECOND CLASS COACH FOR THE BODMIN AND WADEBRIDGE RAILWAY.

FIG. 2. HOW THE HERO OF WATERLOO TRAVELED.

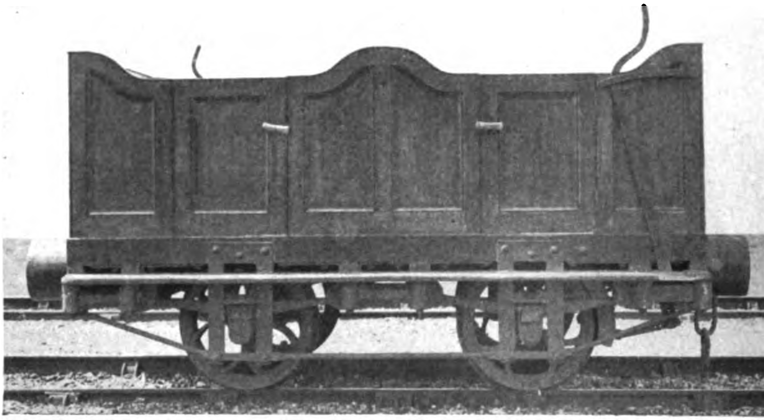

Fig. 3.

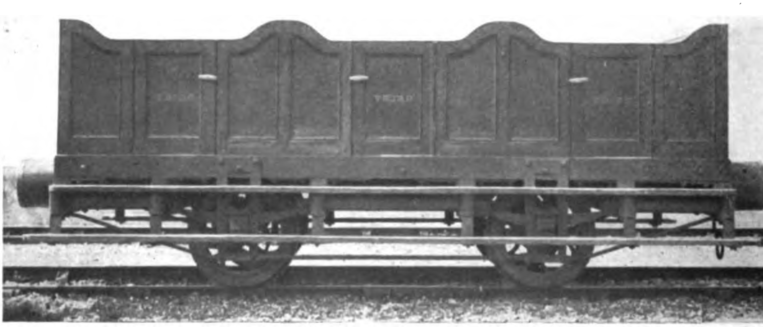

Fig. 4.

Early British Railway Carriage Building.

Old Third Class Coaches for the Bodmin and Wadebridge Railway.

be seen on out-of-the-way branch lines in Great Britain with the iron rails, to which the baggage was secured by ropes, running round the roof.

Our illustrations of an old second-class carriage for the Bodmin & Wadebridge Railway, now part of the London & South Western, and of an old first-class carriage for the South Eastern line, represent very clearly the position to which the development of the railway passenger coach had arrived in the late thirties. The former example, like the others to be presently mentioned for the same line, is supposed to have been built about 1835. It is 10 feet long over the body and 6 feet 5 inches wide. The extreme height above the rails is 8 feet 5 inches, the wheel-base, or distance between the points at which the wheels touch the rails, is 6 feet 4 inches, and the weight about two and a quarter tons. We may recall, for the sake of comparison, that this weight is about one-third of the weight which each axle of a modern passenger coach carries.

The first-class coach was built by the South Eastern Railway, now the South Eastern & Chatham, and set apart for the use of the Duke of Wellington, when the great soldier-statesman became Lord Warden of the Cinque Ports, and took up his residence at Walmer Castle. As our illustration shows, it is of the form to which the name "Dandy-coach" has been given. It consists of one central compartment, almost an exact replica of the stage-coach, even to the door handle, while at either end a very small and cramped compartment is provided for the servants. Two oil lamps light the three compartments. Decided improvements are noticeable in the spring-buffers and screw-couplings.

Both these vehicles, as my readers will notice, are the lineal descendants of the old road coaches; that is, they

are built for the accommodation of the same class of traffic, those passengers, in other words, who were ready to pay the old coaching fares. But a great number of people were eager to be carried by rail who would never have dreamt of the long and expensive journey which coach-travel entailed. Moreover, the passengers by the old stage wagons had to be catered for. From these circumstances arose, in Great Britain and Europe generally, the provision of second- and third-class carriages. Two of these latter my readers can now study. One has three compartments and is 14 feet 10 inches long; the other has two compartments with length of 10 feet. The weights are respectively two tons eighteen hundredweight and one tone nineteen hundredweight. These little carriages are quite typical of the third-class stock generally in use up to about 1850. "Dead" buffers are used, *i. e.,* wooden buffers without springs, and the carriages are coupled by loose chains. The smaller of the two is interesting, as being fitted with a couple of levers, as will be seen in the picture, fitted at diagonally opposite corners, each of which actuated one brake block on one wheel. The height of the bodies above rail level is only 5 feet 10½ inches and 5 feet 5 inches respectively. Above this no protection whatever is afforded to the passenger.

The Bodmin & Wadebridge Railway is six miles long and was built as a standard gauge line, at a time when its big neighbour, the Great Western, was broad gauge. It held aloof from this overpowering influence and existed in lonely isolation for more than half a century. The train service consisted of one train about twice a week each way. It finally fell into the arms of the Great Western's rival, the London & South Western, who took over and rebuilt the road in question in 1894, in pursu-

ance of their policy of getting a footing on the North Cornwall coast.

The few examples I have given will, I hope, have given the reader some idea of the general features of the travelling arrangements which the railways instituted. It will be seen that, save in the one important matter of speed, not much had been gained. And even in this respect the second- and, especially, the third-class passengers were by no means well off. The best trains for long were first-class only, the third-class passenger being in all ways relegated to the background. Thus, on the opening of the London & Birmingham Railway in 1838, the times for the one hundred and twelve miles were as follows:

First-class mail-trains, 5 hrs. 15 min.

First- and second-class, "mixed," 5 hrs. 30 min.

Third-class, 8 hrs. 45 min.

This last was not much better than the best coaches, which completed the journey in ten hours. Contrast this with the two-hour expresses and third-class dining-cars of to-day!

It does not seem possible to determine which line actually took the lead in supplying covered-in third-class carriages, fitted with seats. But by about 1840 this improvement was becoming fairly general. The closed-in thirds were not for some time fitted with windows, probably this last innovation must not be placed earlier than about 1850, and even then the windows provided were very small, about seven inches by ten inches. The lighting too, was very bad, consisting of one small, dim, evil-smelling and uncertain roof-lamp. How this type of coach has gradually developed into the comfortable vehicle of to-day will be our pleasant task to trace in the following pages.

Meanwhile, one other circumstance remains to be referred to in closing this chapter. We have seen in a very cursory way the first stages, practically the same in all countries, by which the single stage-coach body started to become the multi-compartment carriage. Two offshoots, so to speak, from this main stem must be noticed; one of which seems in a fair way to become the trunk of the tree. In England, and in Europe generally, a type of carriage came into use, especially for third-class, resembling, in its general plan, what English railways to-day call a saloon. This word will seem to my readers somewhat of a misnomer when I say that the early carriages of this type had usually no windows, light being admitted only by means of openings in the sides under the roof, no lamps, and only boards for seats. In fact, in size, shape, and outward appearance generally, they very much resembled the English cattle truck of to-day. Why I ventured to evoke the word "saloon" in connection with these coaches was to try to bring before my readers the seating plan adopted. This closely followed the modern English saloon, the seats running round the sides and ends of the vehicle, with other forms arranged in the centre of the floor. These coaches, though their seating arrangement has long since been discarded for ordinary passenger service, may perhaps not inaptly be regarded as the precursor of the modern picnic saloon or family carriage. They were, of course, very small, and had often only one door on either side in the middle, though usually two. They appeared early on the London & Croydon and London & Brighton systems, whose lineal descendants in the railway world to-day are the South Eastern and the London, Brighton & South Coast. The Manchester & Leeds Railway, now the Lancashire & Yorkshire, also put similar coaches into service about 1840.

The other, and more important, offshoot from the parent stem first took its rise in the United States. Here two striking departures were made, both of which are gradually influencing the course of rolling stock design all the world over. The first of these was the adoption of the bogie or swivelling truck. How this feature of design came to be applied to the locomotive has been told already.* From the locomotive shop the bogie soon passed into the carriage shop and with its advent things began to move. In the first place the use of the truck enabled much longer carriages to be built. Hitherto the length of the carriage had been determined by the sharpness of the curves round which it had to pass. This, in those days, before the invention of radial axle-boxes and various other devices, limited the overall length of a coach to about 18 feet. The adoption of the bogie has increased this dimension to a maximum of about 75 feet. This, however, was not reached all at once. Prints of early cars show car bodies consisting of three of the old compartments supported on bogies. No dimensions are available, but we may suppose the length would not exceed 24 feet: but at any rate the car-builder had had a door of escape from old conventionalities opened to him, and through this he was not long in passing.

This brings us to the next striking departure, for which the travelling world has to thank the American designer. In this the build and the whole outline of the stage-coach were boldly abandoned. The builder went to the stage-wagon for his idea and carried the plan out into the design of a railroad *car*. Such a vehicle presents the essential features of a passageway, or "aisle," down the centre, with seats arranged, usually transversely, on either side, the only means of entrance or egress being by doors at either end leading to a small platform.

* In the "Boys' Book of Locomotives."

This type of vehicle leapt into instant popularity in America and has profoundly modified travel conditions all the world over, especially for long distances. Of its advantages and disadvantages and the various modifications of the original idea which are now in service we shall learn more as we go on.

We may fittingly close this chapter with a reference to the picture of an early American passenger train modelled on the new lines, the development of which I have just recorded. Here we have, in a very crude and imperfect form, the idea from which has sprung the "Pennsylvania Limited" and other luxurious and beautiful trains of to-day. The cars are narrow, low and cramped, but still they are cars, not carriages: and, uncomfortable as they must have been to the travellers of seventy years ago, we are now concerned with the thought of what those bogies and end doors have meant in the history of travel.

The cars and the curious roofed-in tender were all built in America: the locomotive was built in England by the famous Stephensons, and received in consequence, from its runners and the public, the nickname of "John Bull." The pony truck and headlight were added after the engine had been at work for some little time. This little train was put into service about 1831 on the Camden & Amboy Railroad, and has been exhibited as an interesting link with the past by the Pennsylvania, into whose great system the original line has long since been absorbed and to whom we are indebted for the photograph.

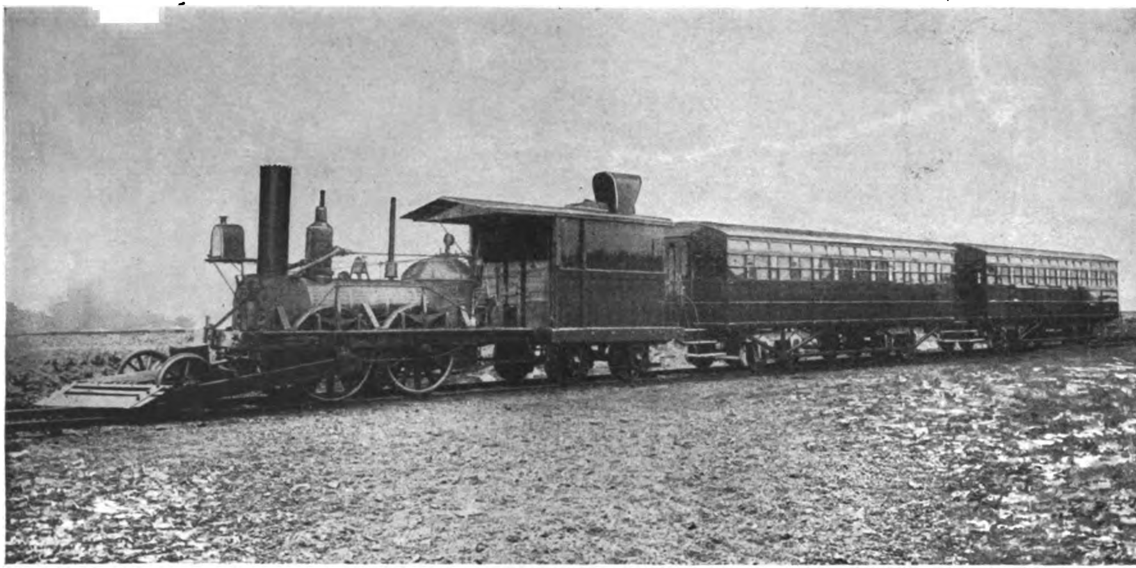

FIG. 5. EARLY AMERICAN BOGIE CARS ON THE CAMDEN AND AMBOY RAILROAD.

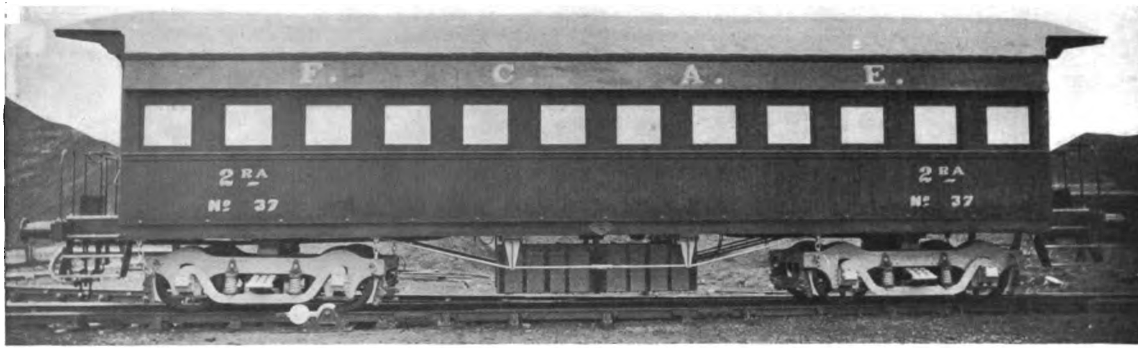

Fig. 6. Example of Passenger Car with Steel Underframe for the East Argentine Railway.

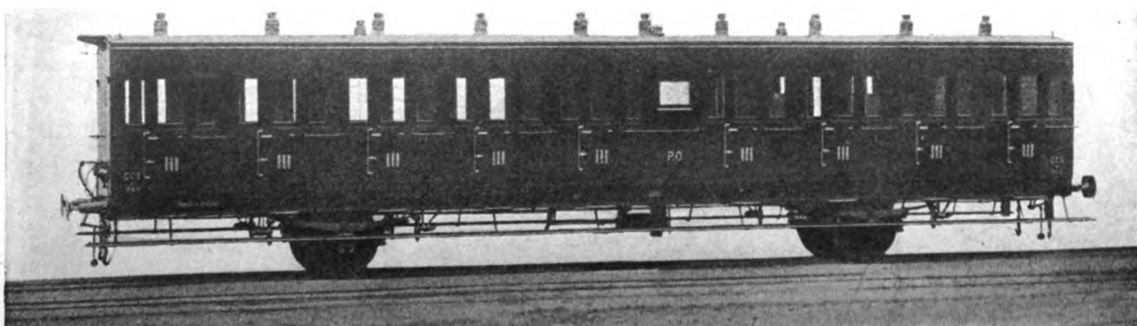

Fig. 11. Long Four-wheeled Carriage for the Paris-Orleans Railway.

II

The Building of a Passenger Coach

The two chief materials used in coach building are wood and iron. The latter, in the form of steel, is now much more used than formerly and is superseding wood very rapidly. The early vehicles already illustrated were built nearly all of wood, the ironwork being confined to the axles, wheels, and springs. Nowadays the framing of the coach is often of steel, while sometimes even the outside body panelling is composed of thin sheets of the same metal. The usual British practice, however, we may take to be, steel for the sole framing, bogies, and axles, and wood for the body. In America the bogie frame also is usually built of wood.

Wood is divided by the coach-builder into two main categories, hard wood and soft. The former comprises the various kinds of oak, teak, mahogany, walnut, and sycamore. Of the first-named, English oak is considered the best, though the American oak is the more useful as being obtainable in much greater lengths. The best teak comes from the East Indies. It is a very greasy wood and does not take a high polish, but there is a very businesslike look about, let us say, an Anglo-Scottish East Coast vestibuled train with its uniform panelling of sober teak. Mahogany, walnut, and sycamore are used chiefly for interior panelling and other ornamental purposes. The last-mentioned is very useful as, being of a rich cream colour when polished, it forms a very handsome relief to dark pilasters of walnut or other wood.

The principal soft woods are the various varieties of pine and fir. These come from Canada, the Baltic ports, and Norway. Timber of this description is used for building the sides of goods wagons, and for floor, roof, and partition boarding generally. The immense Kauri pine of New Zealand and Australia and the pitch pine of the United States must also be included under this category. We may remark just here on the rapid consumption of the world's timber supply. This is a matter which concerns governments chiefly, and is therefore, to that extent, outside our present province. But it also intimately concerns railroads and car-building companies, and some day these concerns will wake up to the necessity of taking some steps to provide for their own future supplies instead of going on in the present hand-to-mouth style. Some beginning in this direction has already been made by the Pennsylvania Railroad. They have a seventy-acre farm at Morrisville, Pa., on the main line between New York and Philadelphia. Here thirteen acres are devoted to raising trees from seed under carefully planned conditions to facilitate growth. The timber at present being experimented with is designed for ties, or sleepers, as the British term is, but if successful no doubt timber for car-building will be taken in hand.

The trunk of a tree, from the coach builder's point of view, is divided into four parts, which form, roughly speaking, four concentric circles. The innermost of these is the heart of pith. Immediately outside this comes the heartwood, which, when the tree is cut up longitudinally into boards, forms the most durable, useful, and valuable part of the wood. Outside the heartwood comes the sapwood, and outside this again the bark. This is the least useful part of the tree, except in certain special cases, such as the cork tree.

Trees vary very much in their time of coming to maturity. English oak takes as much as one hundred years. This fact, together with the greatly increased length of railway carriage frames, helps to explain why it is that steel is now such a favourite material for this important part of carriage construction. The 60- or 70-foot cars in use to-day could seldom be built without joints in the longitudinal members of a timber sole-frame, whereas steel beams can be readily cast to any desired length. The picture (Figure 6) of a second-class car for the Argentine Eastern Railway gives a good idea of the longitudinal steel beams upon which the body of the car rests. This car was built by Messrs. R. Y. Pickering & Co., of Wishaw, near Glasgow.

After a tree has been felled, which should always be in the winter time while the sap is at rest, it is taken to a convenient drying ground. Here the logs are assembled, often after long journeys by land or water, and carefully stacked for from a year and a half to two years. Before being stacked the logs are roughly squared up, to promote the drying or seasoning process. In this condition the timber receives in America the technical name of lumber, though this term is often loosely used at any stage after the tree has been felled. After this first period of seasoning the log is cut lengthways into planks of dimensions varying according to the use to which it is designed to put the timber. These planks are again stacked for a further period of about two years, after which they are cut up into smaller pieces or scantlings, as they are called, of various sizes. The scantlings have another year's seasoning, after which they should be ready for use. This long five years' treatment is to ensure that all the moisture of the wood shall be dried out. If this were not done decay would speedily set in and the

life of the car or wagon to be built from it would be a very short one. The principal agent in the drying process is air, which, circulating freely around each log, carries away the moisture with it. To allow this air circulation to be as free as possible the stack of logs is raised off the ground on blocks of damp-proof wood, and packing pieces are placed between each log and the one on which it is resting in the stack. The drying ground should be concreted and roofed over, so as to exclude damp both from below and above, but the sides are usually left quite open. Logs thus dried lose as much as one-third of their weight, with a considerable decrease in their thickness as well.

The length, and consequent costliness, of this process of natural seasoning, as it is called, has led to the adoption of various methods of artificial seasoning. In one of these methods the timber is dried by being stacked as before, only in a closed building with hot air circulating around it. In others it is steamed or boiled, and in yet another it is chained down in a stream of fresh water immediately after felling. After about three weeks of complete submergence it is taken out and dried.

We will now turn, if the reader pleases, to consider together the design of a railway vehicle. In this design the car-builder has to take note of two or three primary factors, upon which all his planning has to be based. The first of these is, of course, the weight which has to be carried. His first care must be to provide a rigid and unyielding platform on which this weight can rest. The next factor which he must take into account is that this platform which he is providing will not be stationary, but will be subject to violent pulling or pushing about. He must therefore not only build it so as to be rigid in a vertical, but also in a horizontal direction. These hori-

zontal strains and stresses are far more severe in a lengthways than in a sideways direction. This determines him in arranging his available material especially with a view to longitudinal resistance. Then, and finally, economy demands that those members of the car frame and body, which experience has shown to require renewal soonest and oftenest, shall be, as far as possible, so arranged that they may be taken out and replaced with the least expenditure of time and labour. This applies especially to drawing and buffing gear, which have to take up the shocks transmitted to the car in running.

The underframing, or sole framing, as it is often termed, of a railway vehicle, consists essentially of a number of beams laid in the direction of the vehicle's length. These beams may be, as we have already seen, either of wood or steel. Their number varies, not only with the size of the coach, but also with the size and material of the beams themselves. Thus the new suburban cars for the Illinois Central, illustrated in Chapter V., have underframes consisting of only four I-shaped steel beams. These beams are nine feet deep and spaced nearly equal distances apart. On the other hand, the magnificent car, of which we have a picture in Figure 7, has no less than eight longitudinal members in its underframe. These have a cross-section of 8 inches by 5 inches for the principal members, and 8 inches by 3 inches for the intermediate ones. This car was built by the Barney & Smith Car Company, of Dayton, Ohio, for the Empire State Express service of the New York Central.

These cars are 9 feet 8 inches wide over the side sills and 70 feet long over the end sills or headstocks, as they are called in England. The extreme length over the face plates of the vestibules is no less than

77 feet 5½ inches, while the weight totals up to, approximately, 100,000 pounds, or 44.6 tons English. These fine cars seat eighty passengers each and though, of course, running in limited trains, may be considered to correspond to the British third-class carriage or car for similar duty. The Empire State Express is one of a splendid group of fast expresses maintained by the New York Central & Hudson River Railroad. Its title comes from the fact that unlike most of the other New York Central expresses, its daily run begins and ends in the Empire State of New York. The New York Central, like the English Great Northern, is peculiar in this respect that most of the important cities to which its trains run lie beyond the limits of its own tracks. The Empire State Express is not, therefore, as American trains go, really a long-distance train, though its 440-mile trip would in most other countries fairly come under that designation.

This train will have reached its thirteenth birthday by the time this record of it appears in print. It appeared as one of the early examples of the modern high-speed expresses and so demands some notice before we pass on. There are about eight roads in various parts of the world which have been chiefly instrumental in breaking away from the old forty-miles-an-hour standard of express speed and inaugurating a new class ten miles an hour higher. These roads are, in Great Britain, the Great Northern, Great Western, and London & North Western; in France, the Nord and the Orleans; in Germany, certain divisions of the Prussian State system; and in America, the New York Central and, for short runs, the Philadelphia & Reading. In the wake of these pioneers the other big roads have since followed, but the fact that, by the inauguration of the "Empire State," the New York Cen-

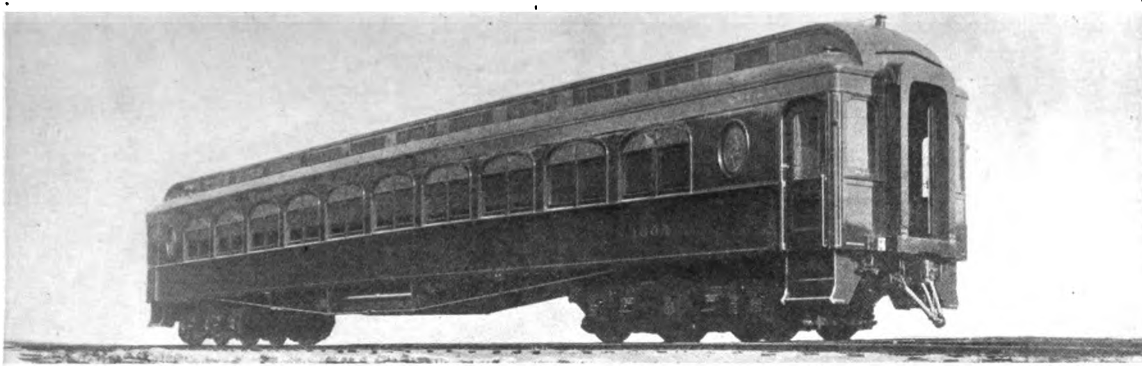

FIG. 7. A MODERN AMERICAN PASSENGER CAR. NEW YORK CENTRAL AND HUDSON RIVER RAILROAD.

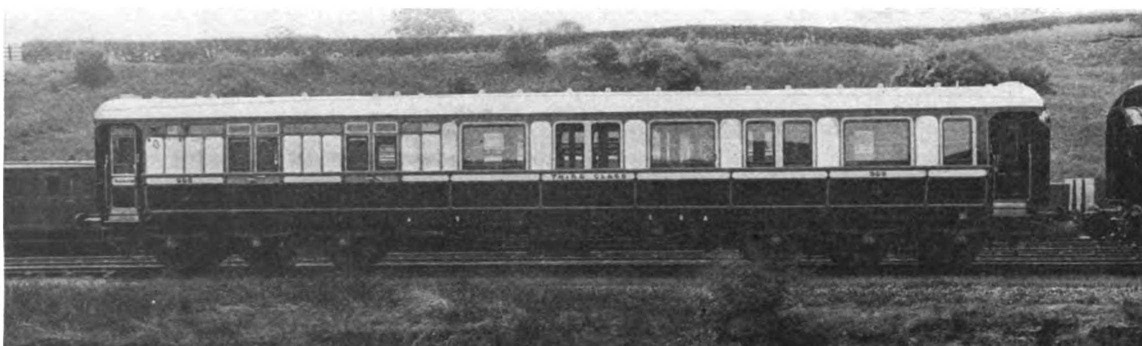

FIG. 8. VESTIBULED CAR FOR ANGLO-SCOTTISH SERVICE, WEST COAST ROUTE.

tral became one of the pioneers helps to give to this splendid train its great interest for the railway student. I can, I think, most easily bring before my readers the performance of this train by exhibiting it in tabular form. The following table shows all the intermediate stops.

THE EMPIRE STATE EXPRESS

STATIONS	Time	Miles from New York	Miles from previous stop	Average speed between stops
	A. M.			
New York (Grand Central Station)....dep.	8.30	......	......	......
Albany ....arr.	11.10	142.88	142.88	53.58
	11.13	......	......	......
dep.	P. M.			
Utica ....arr.	12.52	237.55	94.67	57.37
dep.	12.55	......	......	......
Syracuse ....arr.	1.58	290.72	53.17	50.63
dep.	2.01	......	......	......
Rochester ....arr.	3.25	371.10	80.38	57.41
dep.	3.28	......	......	......
Buffalo ....arr.	4.45	439.52	68.42	53.71

The most noticeable features about the running of the train are its relatively short runs between stops, judged by the standards of to-day, and the fine bursts of speed along the Mohawk Valley. As an offset to the fairly heavy weight of the train we ought to notice that the engines have their task facilitated by an almost faultless roadbed and a remarkable absence of heavy grades. The average speed throughout works out a 53.27, including stops.

Now, if we turn back again to our picture, we may also get an idea of the nature and function of the truss rods, as they are called. In all vehicles supported at or near

their extremities there is a natural tendency to sag in the middle. The longer the unsupported part is, the stronger the tendency will be, so when we come to long, bogie cars like the present it is necessary for the builder to adopt some means to resist this tendency. I expect we have all of us seen at some time or another old vehicles, usually freight cars or goods wagons, in which the defect has grown so pronounced as to be apparent to the eye. I have also seen wagons in which the opposite weakness has manifested itself. This defect is known as hogging, and consists in a drooping of the ends and an upward curve about the middle of the vehicle. This tendency is not, as a rule, a very serious one in the case of railway rolling stock, though, as I have pointed out in an earlier volume of this series, it is one which has to be carefully provided for in shipbuilding.* Hogging, in a railway wagon could only mean that the vehicle had been very heavily loaded at its extreme ends, with the centre left empty, and probably with the added torture of being subjected to severe buffing strains in that condition.

The sagging tendencies of long cars could be met in two or three different ways. The builder could increase the depth of his longitudinal members about their centre so as to make them stiffer there. As we shall see in Chapter X. this is actually what is done in some cases for very heavy freight. Or he could erect posts over the bogies and support the centre by cables after the plan of a suspension bridge. This would be for a railroad car both ungainly and cumbrous, and so we come to the plan most commonly adopted of these underneath truss rods.

On looking again at our picture my readers will see two stout iron posts projecting downwards from the

* The Boys' Book of Steamships, page 51.

underframe near the centre of its length: actually, in the car we are studying, these posts are 10 feet 6 inches apart, in other words, 5 feet 3 inches on either side of the centre. Through eyes in the lower end of these posts passes the truss rod, which in this case is really two rods coupled together in the middle, and which is firmly anchored at either end to the underframe in a line with the bolster of the bogie on which it rests. This rod is of iron about 1⅛ inches in diameter, and there are four of them, supporting the four principal members of the underframe.

We have now got the longitudinal part of our framework well in our mind's eye, I hope, but these members need cross-pieces to hold them together. The chief of these cross-pieces are the end sills or headstocks. These are of similar cross-section and shape to the beams running fore and aft, but they are or course much shorter. Beside these principal cross-beams, others are built-in between the frames at intervals of about eighteen inches or twenty inches throughout the length of the car. In the case of steel frames these various beams and cross-beams are all securely riveted one to another, and in the case of timber frames secured by mortising and tenoning and then by bolting together.

The whole of the underframe is thus designed to provide a very strong, rigid platform which will carry its allotted weight without yielding, even though it may be subjected to the shock and strain of being dragged at express speed over junctions and round curves. All that we have so far learned concerning it is universally true of railroad practice all the world over. Whatever the vehicle be, whether an English compartment carriage or an American car, the principal members of the underframe are practically identical.

Now, however, we come to a point of divergence. The function of the English headstock is different from that of the American end-sill in one important point. At least it is so as regards passenger stock; when we come to deal with freight equipment the case is a little different. If, now, the reader will compare with the New York Central car the one built for the Anglo-Scottish service of the East Coast route, and illustrated on the same page, the difference of which I am speaking will, I think, be clear. In the British car the headstocks really do come at the ends of the vehicle and carry the buffers, coupler, and vestibule, all of which duty is performed in the American coach by platforms built out from the end sills and projecting to an extreme depth of 3 feet 8 inches from them. This is true, in spite of the fact that the fine East Coast car used in the comparison is, in many ways, a very American vehicle, being equipped with Gould vestibule and automatic coupler. In the American-built car the two centre longitudinal beams are run out through the end sills so as to form a foundation on which to build the platform.

Coincident with these external differences there are also internal ones. Thus the English use of side buffers renders necessary the provision of diagonal beams in the underframe which can take up the shock of buffing and transmit it to the centre of the frame. The Argentine Eastern car, at which we have already glanced, affords an instance of the American arrangement of platform combined with typically British buffers and couplings.

The general idea underlying the construction of the underframe is now, I hope, sufficiently before us, and we may sum it up by saying that this underframe is, geometrically considered, a rectangle in shape, with the width fairly fixed at something under 10 feet and the length

a variable quantity ranging from 20 to 30 up to nearly 80 feet. This frame is stiffened, transversely by numerous cross-pieces, longitudinally by two or more centre beams parallel with the sides, and vertically, in the case of vehicles of any length, by suitably arranged truss rods. This brief summary may be taken as true of all railway vehicles all the world over, though, as we have already seen, there may be modifications in detail in the practice of different countries.

Now, I want my readers to turn to the very interesting question of the means by which the vehicle is to be carried. The body framing we will defer to the next chapter. But the wheel arrangement presents some remarkable varieties, not only for different duties, but also for substantially the same duties. Leaving out of count small inspection trolleys, worked by hand, which have sometimes been built as tricycles, the minimum number of wheels for any railroad coach is four: while, also leaving out of count very extraordinary vehicles for the transport of very special loads, such as, for instance, railway gun carriages, which have been used in Woolwich Arsenal or the Bethlehem Steel Company's 32-wheeled crocodile car, the maximum number of wheels may be taken as sixteen, and far more usually, twelve. In Chapter X. we shall have an interesting example of the very exceptional sixteen-wheeled: just now we will not go beyond our more ordinary twelve.

In America, rolling-stock design seems to have taken a great leap forward, from the four- to the eight-wheeled coach, a development due to the adoption of the bogie. In Europe generally, and in Great Britain in particular, this was not the case, so we will begin our survey on the east of the Atlantic. We have already seen, in Chapter I., examples of early four-wheeled stock. We must re-

member that this class of coach was in extensive service in Great Britain, even for express trains, until, let us say, about twenty years ago. With carriages grown a good deal larger, measuring up to about 27 feet long, and accommodating five second- or third-class compartments, or four first, the four-wheeler might be seen on the fast trains, more particularly of that group of English railways running from London south of the Thames. Since the "eighties," however, carriages of this class have been gradually restricted, in England, to slow, and specially to suburban passenger service. For the latter duty this type of coach has been, and still is, a great favourite with English designers on account of its large seating accommodation in proportion to size, weight, and cost of construction.

On the continent of Europe there seems to have been lately rather a reaction back again to the four-wheeler, even for main line service. We have here two examples of recent practice in this respect. The first is a four-wheeled third- and fourth-class observation car for the Prussian State Railways. This car was built by the Breslau Railway Wagon Company, and, in spite of its two axles, is quite modern in its build and equipment. As our picture shows, it has a clerestory roof and steel underframe, while its equipment includes gas lighting and even window curtains for the fourth-class compartment.

Our other example, illustrated on the same page, is an even more remarkable vehicle. It was built in 1900 by the Compagnie Française de Matériel de Chemins de fer at Ivry Port for the express services of the Paris-Orleans Railway. The length of this coach is no less than 48 feet 5½ inches between end-sills, while the breadth over all is a shade less than 10 feet 2 inches. The

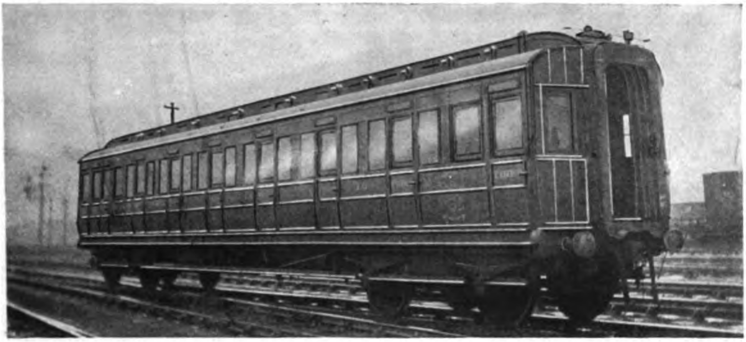

Fig. 9. Third Class Compartment Car East Coast Joint Stock, equipped with Automatic Couplers and Vestibules.

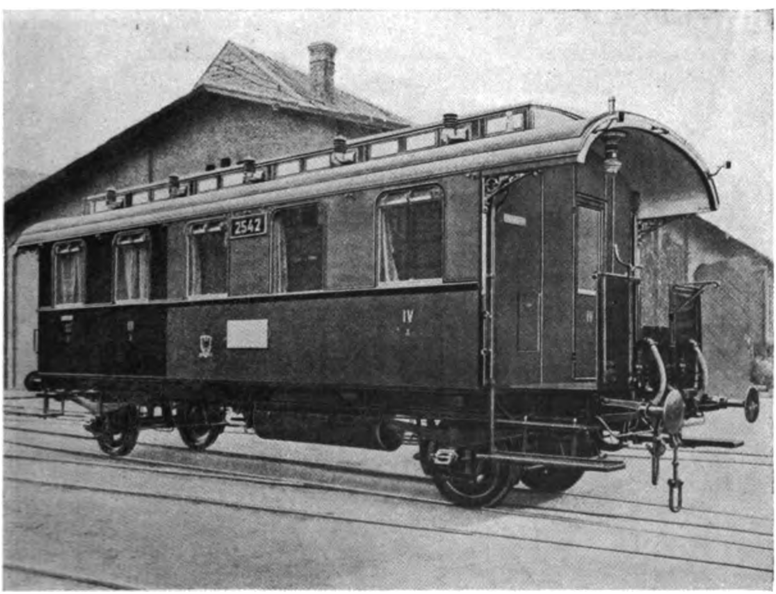

Fig. 10. Composite Third and Fourth Class Car. Prussian State Railways.

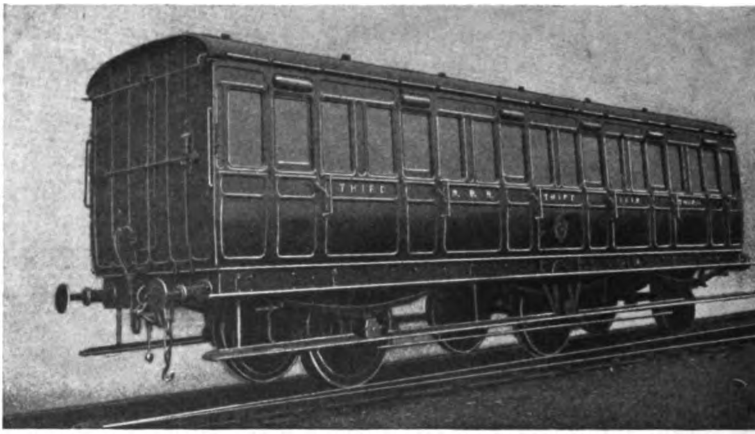

FIG. 12.

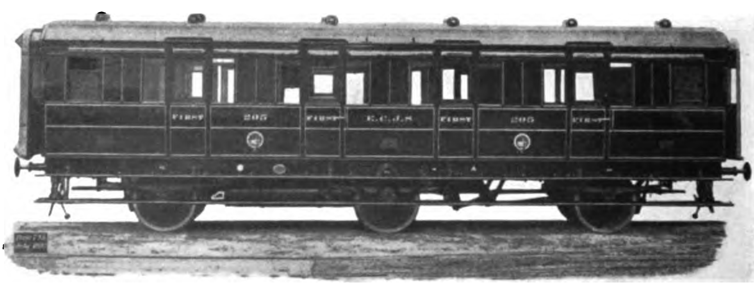

FIG. 13.

THE ENGLISH SIX-WHEELED COACH.

FIG. 12. THIRD CLASS CARRIAGE, NORTH BRITISH RAILWAY.
FIG. 13. FIRST CLASS CORRIDOR CARRIAGE, EAST COAST JOINT STOCK.

weight, empty, is only 13.65 tons. As the picture shows us, there are nine compartments, all third class, with one lavatory compartment near the centre of the coach. A corridor runs down one side giving communication between all the compartments and the lavatory. The two end compartments seat nine passengers each, and the intermediate eight, giving a total carrying capacity of seventy-four people. The compartments are not upholstered in any way, though they are provided with parcel racks. The coach is equipped with Wenger air-brake and electric train signal. A feature of the construction which helps to account for the light weight is the adoption of sheet iron for the outside panelling.

This type of coach, though a complete retrogression from modern practice, is said to be very easy in running and comfortable to ride in, being steady even at high speeds. We shall not, I think, be doing an injustice to the Paris-Orleans Company if we say that its extreme cheapness, both in first cost, in upkeep and also in cost of haulage is a great point in its favour. All of these factors are coming to have more and more weight with railway companies who are finding themselves called upon to haul ever-increasing loads with ever-diminishing seating capacity. Nevertheless, it must be confessed that this type of carriage, quite apart from its internal fitting, cannot be regarded as really satisfactory from the point of view of present-day working.

The next step forward in Europe was the introduction of the six-wheeled coach. This type of vehicle was, with British lines specially, a great favourite for, we may say, three whole decades. For all that time it was, practically, the standard for main line service on every British line, with but three exceptions, the Midland, the London & North Western, and the Great Western: and even

on these three systems where we cannot quite call it a standard, there were a great many six-wheeled coaches running.

The addition of the extra pair of wheels increased, normally, the length of the coach. The Paris-Orleans example, at which we have just looked, you must please regard as quite abnormal. But, of course, this increased capacity lengthways was to some degree offset by the increased difficulty of coaxing the six-wheeler round curves. A little thought will soon show us that a carriage supported only near its extremities, even with a fairly rigid wheel base, will go round a curve much more readily than one in which three axles must remain parallel to one another always. As a matter of fact, if you keep your three axles absolutely parallel they can only adapt themselves to a curve by one or more of them moving sideways under the coach. A close scrutiny of the picture of the East Coast six-wheeler in Figure 13 will show that the springs of the centre pair of wheels are not attached to the hanger directly, as the two end pairs are, but by means of an intermediate link. This provides 1½ inches side play for the centre axle, thus enabling the wheel base of the vehicle to adapt itself to a curve. But, in addition to the sideways movement, coach builders often exercised their ingenuity to allow a certain amount of turning movement to one axle at least so that it was not held rigidly parallel with the others. This was accomplished either by some device of radial axle box or by arranging one of the two end axles in a Bissel truck.

The annexed representations give us some idea of the modern British six-wheeler. The first of the two pictures shows us a third-class coach for the North British Railway. This carriage has six compartments with seat-

ing accommodation for sixty passengers. It measures about 36 feet long and 8 feet 6 inches in over-all breadth. Its high roof, with rounded edges, makes it lofty and airy inside. It is built on a wooden underframe and the body is painted the standard North British dark red. The carriage is lighted with gas and equipped with the Westinghouse airbrake and passenger communication. The lever of the stop-cock for the gas supply can be seen across the end of the coach body, and the indicators of the Westinghouse passenger communication may be seen above this, just under the roof. These coaches were practically the standard on the North British for some years, but the advent of newer types of vehicles is fast relegating these six-wheelers to the slower main and branch line trains.

Our next picture shows us one of an interesting class of carriages, built by the Gloucester Railway Carriage & Wagon Company for the East Coast Joint Stock, to run between London and Scotland. The partners in the ownership of this Joint Stock are the Great Northern, North Eastern, and North British Railways. The East Coast Stock has always conformed in outline and general design to the stock of the first-named company, the only differences being in the shading of the lettering and other details of finish, and, a more important matter, in the slightly greater width of the coaches for the Scottish services.

The present example is specially interesting as being one of the earliest instances of the now widely popular corridor carriage. There are lavatories at either end, for men and women, respectively, and a corridor runs down one side of the coach, into which the compartments open. As originally built the lavatory compartments stretched right across the body of the vehicle, but when, in 1893,

dining-cars began to run on some of the through Scotch expresses, means were provided for passengers to obtain access to the diners from other parts of the train. This was at first done by extending the corridor through the lavatory compartments, cutting a doorway through each end of the coach and adding a flexible covered gangway between the adjacent carriages. Our picture shows carriage No. 205 in this condition. But, the side gangways proving very cramped and inconvenient, they were subsequently removed, and all these neat little six-wheeled corridor coaches equipped with real vestibules, of the Gould type, and automatic couplers.

The gas lighting and "torpedo" ventilators on the roof were both added some time after the carriage had begun running. The gas cylinder can be seen underneath the carriage and the gas metre appears affixed to the sole bar above, close to the oval name plate of the builders. When this coach first came out the Great Northern used Smith's simple vacuum brake. Later, Gresham & Craven's Automatic Vacuum was adopted and the letter A, screwed on to the solebar of the vehicles, indicated those which had been converted to automatic. Nowadays, when nothing but automatic is in use, the A serves to guide shunters to the wire for releasing the brakes. The other East Coast partners use the Westinghouse, and the W, also affixed to the solebar, serves to guide to the release cock of this brake. The chief dimensions of this class of vehicle are now, length over vestibule face plates 41 feet, width over all 8 feet 6 inches. They weigh about eighteen tons and seat sixteen passengers.

Like nearly all British six-wheelers, they are very comfortable to ride in. The comparative stiffness of the extended wheel base seems conducive to smooth run-

ning when the roadbed is in first-rate order and the curves not too sharp: on a bad road the story is rather different. But the East Coast route is famous in railway history for fast running and therefore for a well kept road, and even to this day vehicles of the type we have been considering may be seen on through trains. As a personal testimony to the merits of the six-wheeler I may recount a memory of the great year of the race to Edinburgh—the summer of 1888.

In the late August of that year I have on record a trip between York and King's Cross made in coach No. 137, of the North Eastern Railway, a six-wheeled tri-composite. The compartments were arranged—Second—First—Luggage Cupboard—First—Third, and the weight of the carriage was about sixteen tons. At sixty miles an hour this little vehicle was so steady that a well-filled tumbler of water was held in the hand without spilling. But the train was running late and on the well-known galloping ground between Grantham and Peterborough the speed touched eighty-four, and truth compels the admission that at that speed the oscillation was considerable.

From the six-wheeler we pass to the eight-wheeler. Early eight-wheeled vehicles in Great Britain were often built with a peculiar arrangement of wheel base, the two centre pairs being rigid, while the two end pairs had considerable liberty of movement. These remarks apply specially to the Great Western and London & North Western lines. On the latter, especially, a very large number of eight-wheelers was in service, fitted with Bissel trucks, such as we have already referred to in speaking of the six-wheeled type. The riding in these vehicles was particularly quiet and soothing.

But the most usual arrangement nowadays is to have

the eight wheels grouped into two four-wheeled bogie trucks. For this feature of modern practice the whole railway world is indebted to America, where the plan was first made into a standard of practice. American cars began to be built with bogies from the early thirties, and the feature has been a distinguishing mark of American railroad work ever since, and one, moreover, to which the whole railroad world is now rapidly conforming.

The credit of introducing the bogie as a regular pattern of passenger coach building into Great Britain seems to belong to the Midland, to whom railway travellers in England owe so large a debt of gratitude, as we shall see more fully later on. For illustration of a modern eight-wheeled bogie coach we have a third-class brake for the Hull & Barnsley Railway. This type of carriage, by the way, reflects very faithfully the Midland practice of to-day in its general appearance, except for the absence of the clerestory in the roof, and it was built, with eleven others of the same class, to run in the through trains between Hull and Sheffield, to which latter town they come over the Midland line. The Hull, Barnsley & West Riding Junction Railway, to give it its full title, only stretches from Hull to Cudworth—fifty-one miles—not even reaching to the second member of its imposing name. At Cudworth its rails join those of the laconic but ubiquitous Midland, over which these through trains run four miles and a half to Barnsley and fourteen more to the cutlery centre, which even from the days of "Ivanhoe" has given its name to "Sheffield blades."

The new coach has no reason to fear comparison with the handsome rolling stock of its powerful neighbour. Modelled, as I have already said, on Midland lines,—it measures 50 feet long over headstocks,—with a body 8 feet 9 inches wide and reaching to a height of 12 feet

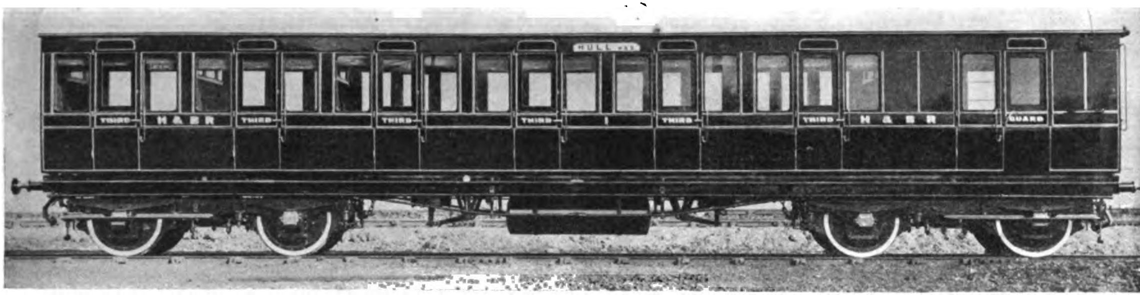

FIG. 14. HULL AND BARNSLEY RAILWAY.

FIG. 15. GREAT CENTRAL RAILWAY.

ENGLISH BOGIE CARRIAGES.

6 inches from rail level. The wheels are 3 feet 6⅞ inches in diameter and spaced 8 feet apart, centre to centre, in each bogie, the bogie centres themselves being 35 feet apart. The equipment includes automatic vacuum brake, steam heat, torpedo ventilators in the roof and Pintsch's gas lighting. A special feature is the lofty elliptical roof which gives a height inside the coach of seven feet six inches clear. All twelve of these carriages were built by Messrs. R. Y. Pickering & Co., of Wishaw, near Glasgow.

A railway traveller does not need to have expert technical knowledge to enable him to appreciate the excellencies of the bogie. In any country, such as England, where bogie and rigid coaches are to be seen on the same train, you will always find the experienced traveller making for the former because he has learnt to appreciate the ease and steadiness of its riding. Now let us try and discover to the traveller the reason for his choice. First of all let us recall the fact that the bogie is a separate little carriage and that all that we have seen already about the underframing of our coach itself applies also, on a smaller scale, to each of the bogies.

Taking the four-wheeled bogie first, we find, running from side to side across its centre, a stout beam, usually nowadays of steel, called the bolster. The weight of the carriage rests on bearings at both ends of this bolster: as in our eight-wheeled coach there are two bolsters, it follows that each bolster bearing carries one-quarter of the weight of the carriage body and underframe. Exactly through the centre of this bolster passes the bogie pin, which is securely bolted to the underframe of the carriage above, and round which the bogie is free to swing. Now the bolster itself rests on nests of springs, cunningly arranged two under each end of it, and them-

selves resting on and fastened to the bogie frame. This last is then carried on the usual side springs which rest on the axle-boxes as in an ordinary coach.

If we take the picture of the Great Central first-class coach (Figure 15) we shall, I think, get a good idea of the arrangement. The frame of the bogie is of steel and one end of the steel channel in and to which the nests of bolster springs are fixed can be seen in the middle of the bogie frame. The side springs which rest upon the axle boxes are of the type called laminated. The Latin scholars will recognise at once, at least I hope so, the appropriateness of the term, for they will remember that "lamina" means a thin plate or veneer, and these laminated springs consist of a number of thin steel plates fastened together in the middle by a stout buckle.

When a load is applied to a spring of this description these plates slip one upon another, thus setting up a considerable amount of friction, as may well be imagined. This causes springs of this type to be rather stiff in their action, and to overcome, or at least modify, this stiffness, special precautions have to be adopted. In the Great Central bogie at which we are now looking, this modification is obtained by coupling the spring hangers to the bogie frame not directly, but through the medium of little helical or coiled springs. Some of these springs can be clearly seen in the picture. Some English builders employ India rubber pads to the hangers instead of the helical springs. Nearly all British railways now use helical springs to carry the bolster, and the triple series of springs makes a very steady, easy-riding vehicle in delightful contrast to the old rigid pattern.

The tempering and testing of these springs is carried out in the most thorough manner. It is most essential

to get all the springs of a car to carry their proper share of the load, and this not merely at the outset, when the vehicle leaves the shops resplendent for its first trip, but through all vicissitudes of railway service. All that the utmost care can do in the way of manufacture, examination, weighing, loading, testing defection, and so on, is done to each spring before it is fitted to any coach; and so thoroughly is this work done that the finished product gives mathematically accurate results in service.

The next type of bogie is represented in a car built by the Gloucester Railway Carriage & Wagon Company for the Ottoman Railway. This interesting line has two principal points of departure, one from Scutari on the Asiatic shore of the Bosphorus, and famous as the scene of Miss Florence Nightingale's work in connection with the Crimean War, and the other from the old-world port of Smyrna, on a deep-cut arm of the Ægean Sea. From Smyrna several branch lines radiate, of which the most important runs south to Ephesus and then two hundred and fifty miles northeastward up the Meander valley. The two main lines meet at Afion Kara Hissar, 261 miles from Smyrna and rather more from Scutari, and terminate, for the present, at Bourlgourlou, about 220 miles further on. Three hundred and seventy-eight miles from Smyrna the line passes through Konieh, a place which under its old name of Iconium is of deep interest to every Christian as the centre of St. Paul's missionary work in the great plain in which the town stands. In old days Iconium stood at the intersection of several Roman post roads and was an important posting and caravan station on the route between Ephesus and the Euphrates valley. We may therefore look upon the standard gauge line of the Ottoman Railway as the successor to the Roman road, and this handsome bogie

car as taking the place of the old "carruca," or travelling coach.

A comparison of this car with those previously illustrated will reveal several interesting differences. Note, for instance, the combination of a quite American type of platform projecting beyond the end-sills with the English pattern of side buffers and screw coupling. In our more immediate concern just now we may observe that the bogie is also a combination of English and American practice. The bolster rests on a large elliptical spring, one end of which may be seen projecting beyond the bogie frame. As we shall see presently, this is quite a typical American type. On the other hand, the laminated side springs and their spring hangers with india-rubber cushions are typically British. This fine car measures 51 feet 5 inches over the buffers, with an over-all width of 10 feet, and a height from rail level to the top of the roof of 12 feet 8 inches, and it provides seating accommodation for sixty first-class passengers,

For our last example of the four-wheeled bogie we will take the comfortable Canadian Pacific tourist car No. 1064. Here we have a bogie of distinctively American design presenting features quite different from the types already studied. In the first place notice that the weight of car and bogie frames is transmitted to the axle-boxes by means of equalising beams. The two ends of these equalisers bear directly on the axle-boxes of the two wheels on the same side of each bogie and the weight is carried on the beams by means of helical springs, replacing the English plan of laminated side springs. The helical springs are much readier of deflection than the laminated, and there is, therefore, no need to arrange any auxiliary springs as in the English type of bogie. Indeed, so easily do helical springs give to a load that it

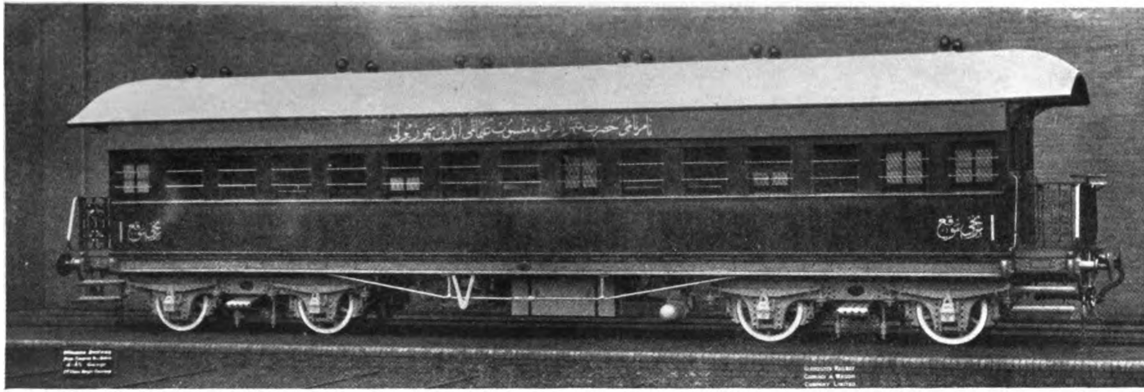

Fig. 16. First Class Car. Ottoman Railway (Smyrna-Aidin).
A Combination of British and American Design.

Fig. 17. An American Four-wheeled Bogie with Equalisers.
Tourist Car, Canadian Pacific Railway.

is found necessary to adopt some means of stiffening them, otherwise excessive rolling is apt to be set up at high speeds, sometimes to such an extent as to cause "car-sickness," the land counterpart of, and produced by the same cause as "sea-sickness." The necessary stiffening is accomplished by having in each nest some of the springs of different deflection to the rest. There will thus be caused a variable resistance to the movements of the car body, resulting in its steadier motion.

This car is about 58 feet long over vestibule frame plates; it is 10 feet wide over all, and the roof reaches to about 14 feet from rail level. It is heated by the old-fashioned stoves, and lighted by oil lamps.

The six-wheeled bogie takes the place of the four-wheeler when either the weight or length of the coach becomes too great for the latter type. We may take six to seven tons as being the normal load per axle for passenger service, though there is a tendency now to considerably exceed this figure. This standard would go to show that for vehicles up to about twenty-eight tons in weight the four-wheeled bogie would be quite adequate, as, for instance, in the Canadian Pacific car we have just been studying together. But this standard has been quite set on one side lately by a type of four-wheeled bogie patented by Messrs. McKerrow & Co., and built by the Leeds Forge Company for the Great Indian Peninsula Railway. The bogie frames are 14 feet 11½ inches over headstocks, and the wheels are spaced 10 feet apart, centre to centre, instead of the usual 8 feet, while the bogie centres are 42 feet 2 inches apart. The coach measures 60 feet over headstocks, 64 feet 10 inches over buffers, and weighs no less than forty tons, a load of ten tons per axle. Large as this figure is for passenger service it is considerably exceeded in freight service, as

we shall see later. This particular class of coach is for the 5 feet 6 inches gauge.

The advantages of the four-wheeled bogie as against the six-wheeled are cheaper construction and reduced weight, owing to the absence of the extra wheels, springs and axle-boxes. But in Great Britain, at least, the length of the coach usually affects the choice of the type of bogie. It happens in this way: Most English lines use a device called the locking-bar, which is a long steel bar pivoted to a switch inside the rail, in such a manner that when the switch is shifted the bar must rise to the head of the rail and fall again. This safety device is to prevent the switch, or points as they are termed in England, from being moved, either wilfully or by accident, while the train is passing over them, to which end it is essential that one pair of wheels must always be over the locking-bar so long as the train is passing. These locking-bars are on most lines standardised to a length of 30 feet, from which it follows that the greatest distance between two adjacent pairs of wheels in a train must not be quite so much as 30 feet, for if the distance in one instance be greater than this, then the condition I have mentioned will not be fulfilled and the locking-bar becomes useless.

Let us say that 29 feet is the maximum permissible distance, centre to centre, between the inside wheels of a bogie coach. The Indian example I have just quoted has the inner wheels 32 feet 2 inches apart and would, therefore, be inadmissible on a road equipped with 30-foot locking-bars. In England, the Great Western, a line which has inherited the tradition of Brunel's bold experiments, and has always been more or less heterodox in consequence, has adopted a 50-foot locking-bar and can, therefore, accommodate practically all its carriage

stock on four-wheeled bogies. The only six-wheeled bogies in service are under some very beautiful sleeping cars recently built at Swindon for the night trains between Paddington and the West.

The accompanying illustration of a Great Western eight-wheeler shows a type of coach which was first built for the famous Cornish Riviera Limited, though a large number have now been put into service and they may be met with on most of the important trains. Owing, however, to their exceptional length, for Great Britain, there are certain sections, even of some of the Great Western main lines, over which they may not run. I believe that these coaches are by far the longest eight-wheelers in the world. They measure 69 feet over headstocks and the body is 9 feet wide over all. The bodies are very lofty, 8 feet 6 inches high, and the roof is 12 feet 6¼ inches above rail level. The weight of the car is thirty-five tons. They have a corridor down one side, lavatories at either end, and the standard Great Western vestibule connections. They are steam heated in winter and gas lighted. The bogies have a wheel base of 8 feet and are 53 feet apart centre to centre, thus making the distance between the two inner pairs of wheels 45 feet, a figure well within the compass of the company's type of locking-bar.

These very comfortable coaches first made their appearance in 1904 and deservedly take their place as some of the finest productions of the historic Great Western shops at Swindon. They were built in pursuance of a vigorous policy of development of traffic, which has affected both passenger and goods departments, and has, incidentally, provided much interesting material for the satisfaction of the railway enthusiast. The first of July, 1904, saw the bold deletion of the only stop then remain-

ing in the journey between London and Plymouth. A new express was put on, leaving Paddington at 10.10 A. M., and running via Swindon and Bath to Plymouth, where it was due at 2.37 P. M., being thus allowed 267 minutes for 245.66 miles, or an average speed, start to stop, of 55.2 miles an hour. Since then, however, the new main line via Westbury has been brought into use and the non-stop trains run over this route, a reduction of nearly twenty miles in distance and a saving of exactly twenty minutes in timing. The distance, according to Bradshaw, is now 225.75 miles and the time allowed is 247 minutes, giving an average speed of 54.83 miles an hour. The arrival time at Plymouth is still the same, but the departure from Paddington is now delayed till 10.30.

This timing is of course extremely good, especially as time is well kept, but it is even better than it looks. The section between Exeter and Plymouth is one of the hardest bits of main line in Great Britain, very hilly and abounding in curves, and an express train is allowed seventy minutes for the fifty-two miles. This means that the booked time for the 173.75 miles between Exeter and Paddington is a trifle over sixty miles an hour. This kind of service obviously demands the very best, both from the locomotive and carriage departments, in order that the trains may be not only fast but comfortable to travel in. And it is for this work that this very exceptional type of carriage has been designed.

But, as already hinted, the most usual form of bogie for coaches over, say 56 feet in length and about thirty tons in weight, is the six-wheeler. To this type, then, we now come as the last of our regular patterns of running gear for passenger stock. In the six-wheeled bogie the bolster takes the form of a large capital H.

The two parallel members of the H are the bolsters proper, running, therefore, as in the case of a four-wheeled bogie, across the carriage. The bogie pin is at the centre of the cross-piece of the H, which cross-piece is securely riveted to the bolster members. These last are placed midway between the wheels of the bogie, one on either side of the centre axle, across which, therefore, the cross-piece runs. You will see that in the six-wheeled bogie there are four points of support for the weight of the body and underframe, as against two points in the four-wheeled type. This, coupled with the fact of the three pairs of wheels, makes a six-wheeled bogie ride far more smoothly than the smaller kind. The fact of the wheel centres being closer together results in the shocks from passing over rail joints, crossings, and points, being received into the bogie at closer intervals, the wheel "beats" become less easily discerned by the senses, and the vibration actually occasioned is less noticeable. And, moreover, the vibration becomes so broken up and distributed through the double bolsters with their double sets of springs that the resultant effect on the coach body is greatly lessened.

I know of no motion on land more exhilarating, and at the same time more soothing, than the gentle swaying of a heavy twelve-wheeler at high speed, especially if it be part of a solid train of vestibule stock. The chatter of the bogies has quieted down to a gentle murmur, and the violent shocks which the car must be receiving, even on a good road, only present themselves to consciousness as a steady swaying motion, which is indescribably pleasant. And, up to all attainable speeds, the greater the pace the less the motion seems to be, until, when your stop-watch begins to register between eighty and ninety miles an hour, you begin to feel yourself part of

the rushing train and to wish you could go on for ever.

Similar differences in design to those which we have already considered in the four-wheeled bogie make their appearance in the six-wheeled type also. We may just briefly consider them together for the sake of completeness. Our first example shall be a vestibuled dining-car for the North British Railway. Here my readers will be able to trace the typically English arrangement of laminated side springs and coiled bolster springs. In Great Britain the middle wheels of a six-wheeled bogie, like the middle wheels of a six-wheeled coach, are usually unbraked. For braking purposes it is usual to throw about half a ton more weight on to each of the end axles than is carried by the centre one. This is accomplished either by having the centre laminated springs of slightly reduced calibre, or by omitting from them one of the plates of which the springs are composed.

This dining-car has a body 66 feet ¾ of an inch long and 8 feet 6 inches wide. The roof attains a maximum height of 12 feet 4 inches from the rail level. Down one side runs a corridor 2 feet wide and giving access to the vestibules at either end. All the compartments measure 5 feet 9⅞ inches from door to door, while the first-class measure 7 feet 5 inches. There are two first- and four third-class compartments, seating a total of eight and twenty-four passengers, respectively. There is also a small compartment for the attendant measuring 4 feet 3½ inches across and a very compact kitchen 8 feet 6½ inches long. Lavatories situated near either end each take up another 3 feet ¾ of an inch of the length of the body. The car is equipped with the Westinghouse brake, which is standard on the North British, and lighted by electricity.

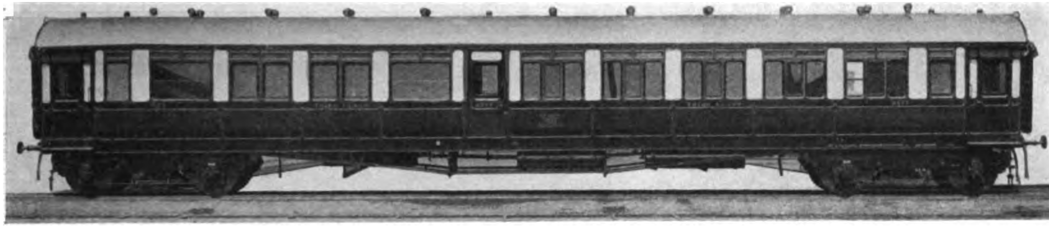

Fig. 18.

Fig. 19.

British Vestibuled Cars.

Fig. 18. Great Western Railway 70 ft. Third. Fig. 19. North British Railway Dining Car.

Fig. 20. Aberdeen Vestibuled Express. North British Railway.

It was built for a new and improved service between Edinburgh and Glasgow, respectively, and Dundee and Aberdeen. Two complete trains were built and began running in 1906. A very good service was given, the trains running the 130½ miles from Edinburgh, Waverley Station to Aberdeen in exactly three hours, with four intermediate stops; while the extra thirty miles from Glasgow took thirty-five minutes longer. These timings were really very good under the circumstances; an average speed of just over forty-three miles an hour, over roads none too easy for the most part, with several service slacks and no long runs, was quite creditable. To accomplish this, the North British turned out a new class of Atlantic type engines, with 2256.2 square feet of heating surface, closely copied from their southern neighbours and allies, the North Eastern. I am sorry to have to add that at the time of writing these new trains have been taken off. This is in pursuance of the policy of all-round deceleration which has come about through the new treaty of peace between the quondam bitterly hostile powers, the Caledonian and North British. Adversity makes strange bedfellows, and it is a new and strange thing in British railway politics to see two lines whose rivalry has before now blazed out in some splendid races to the North, thus entering into alliance. I am all for peace and the avoidance of wasteful competition, but I must say I do not believe it is either right or wise to make wholesale deceleration the outcome. Anyway, Mr. Reid's fine new engines and cars are still left, and one may hope faintly that some day the timings may be restored.

Now, for our American type of six-wheeled truck, let us take an example from the Pullman Car Company's extensive stock. The picture shows the compartment

sleeper "Brazito," and the details of the standard Pullman bogie are easily discernible. It may be well, at this point, to mention the attempt at uniformity of design and dimensions which American engineers have made. In a vast continent like North America, with its thousands of miles of railroad and hundreds of railroad companies, it is of the utmost importance that there shall be complete interchangeability of rolling stock. This is specially the case in the freight business, where a car may pass through the hands of a dozen lines in the course of a single trip, beginning its journey perhaps in sub-Arctic regions and ending it within the influences of the near tropics. But similar need was soon manifested in the passenger business; if through traffic was to be conducted economically it was essential that cars should not be restricted to use on one particular road or even a group of roads. Any car must be able to go anywhere. And not only so, but should any company's car fail when, perhaps, far away from home on another line, it is of the utmost importance that the defect should be remedied promptly at the depot nearest to where the failure occurred. Standardisation secures this and prevents a delay of days or even perhaps of weeks while a broken part was being replaced from home.

Accordingly the engineers of the different roads and car-building firms gradually foregathered to take counsel about these and kindred matters, until at last the Master Car Builders' Association was formed. This great Association, among other good things which it has done, has drawn up a complete list of specifications and measurements to which they recommend that all American cars should conform. These specifications are known as the M. C. B. standards, and to their beneficent tyranny all car owners are now more or less subject.

This digression seemed necessary before I could bring out the fact that the Pullman Company is one of those that are among the less, rather than the more subject. That is to say, they have their own standards for the details of their cars which are not in all cases identical with the M. C. B. Yet even the Pullman cars must, of necessity, conform in any particulars where divergence would render interchange impracticable. Such details include couplers, coupling hose, shape of wheel tread, distance between tires, and others of essential importance.

The Pullman truck is built of American white oak. It must be kept in mind that timber is cheaper in America than in Great Britain, and therefore American builders are able to take full advantage of the superiority of timber over steel, from the point of view of quietness. My readers will understand from what we have already learnt in this chapter, that in every other respect steel has the advantage, but quietness is such a gain, especially in a sleeping-car, that it carries the day. The timber framing of the truck is, however, strengthened in every possible way by steel plates, which are disposed specially with a view to preventing racking of the frame.

The H bolster is not used and the load is carried on three points as in the four-wheeled truck. These points are the centre plate, about which the bogie turns, and the two side bearing bridges. This last feature of the truck is clearly visible in our picture of the "Brazito." It can be seen at the centre of the truck frame taking its bearing upon the powerful elliptical springs on either side of the centre axle. The placing of the side bearing bridges outside the bogie frame is quite a bit of modern practice. They used to be carried inside, but the greater spread afforded by the outside position was found to

check the car from rolling and has therefore been now pretty generally adopted.

A close scrutiny of the picture will reveal the fact that all the wheels are braked, one block to each wheel. This arrangement involves a more complicated system of brake levers and rods than the English practice, but is recommended by the Westinghouse Brake Company. The car is equipped either for gas or electric lighting, being thus ready to travel over lines which use either method of illumination.

The "Brazito" measures 70 feet 6 inches over body, and the underframe is identical in measurement over sills, while the extreme length over the buffer face plates of the vestibules is 78 feet 6 inches. The body is 9 feet 8 inches wide at the side sills, the greatest width over mouldings being 10 feet 0¼ inches. The height from rail level to eaves is 11 feet 3 inches, and to the top of the clerestory outside is 14 feet 6 inches. A corridor 2 feet 2 inches wide runs down one side of the car, giving access to nine staterooms. The weight of this fine car is about 40 tons. The wheels are 3 feet 2 inches in diameter and spaced 5 feet 3 inches apart, centre to centre, while the bogie centres are 54 feet 6 inches apart.

We have now investigated together the various plans of wheel arrangement in common use for coaching stock, from the old and shaky four-wheeler up to the lordly twelve-wheeler of to-day. It only remains, in order to finish off this chapter, for us just to glance at the materials of which the wheels themselves are made. In America wheels having a solid disc of some sort or another are practically universal. In Great Britain this is true of passenger coaching stock, though goods wagons almost always have spoked wheels. On the continent of Europe and in most other parts of the

world the spoked wheel seems to have rather the better of it.

The advantages of the solid wheel in passenger service are twofold: they make far less noise in running than the spoked variety, and the riding of the carriage is softer. Wheels have been built of various materials. The Allen paper wheel was adopted in America, first of all, I believe, by the Pullman Company. This wheel is composed of a number of layers of thick cardboard forced together under hydraulic pressure and secured by a steel tire. The latest variant of this type of wheel is the compoboard.

The "Mansell" wheel, named after its inventor, differs from the others I have mentioned in being a built-up wheel. It is formed of sixteen blocks of carefully selected teak wood, each block being cut into the shape of a segment of a circle, only that the two ends are bounded by straight lines, whereas in a circle the inner end of a segment is a point and the outer end part of the diameter. Perhaps we can better bring the peculiar shape of these blocks before us by saying that a pair of them placed back to back, so to speak, would make an isosceles triangle with its apex cut off.

After being cut, each block is most accurately weighed and the weight marked on for the guidance of the man who actually puts the wheel together. In fitting together his eight pairs of segments, that is, the sixteen segments placed in pairs back to back, he endeavours to arrange them as far as possible so that segments of equal weight shall balance one another by being placed in opposite sections of the wheel. The wooden blocks, carefully filed and scraped, so that there may be no rough edges to prevent a tight fit, are placed together in a ring frame. This frame is provided with suitable

cramping screws to drive the wooden segments tightly together. While in this frame the large centre hole is made which is to receive the boss of the wheel, and also all other bolt holes which may be needed.

The boss is a hollow ring having a deep flange on one edge. The ring is passed into the hole which has been prepared for it in the circle of wooden segments, and so soon as it is firmly home the flange is up quite flat and tight against the segments. The ring frame is still holding the segments in position and we cannot yet speak of them as a wheel. The next step is to slip a flat circular steel plate over that edge of the boss which is projecting through the centre of the wooden blocks. This plate is called the boss washer, and when it is in position it is of course parallel to the flange of the boss itself. There are holes in the boss washer and in the flange, and, as we have already seen, holes have been cut in the wooden segments which will now coincide with the holes in the two steel plates. Bolts are now driven through these holes and securely riveted up so as to hold the whole together. The ring frame may now be removed and we can begin to speak of the various component parts as a wheel.

But our wheel is not yet a circle: it is still an octohedron, a strange figure with eight equal sides. To reduce this to a circle the wheel is now placed upon a very ingenious machine, which will saw off the angular edges and turn it out to a circle of the exact diameter required. When a pair of wheels have been thus prepared and are found to balance one another as nearly as possible, they are ready to be united on one axle. The axle is forced into the boss of each wheel by a hydraulic machine at a pressure of eighty tons. The wheels are now ready for the tires. These are made 3-16 of an inch less in outside

diameter than are the wooden centres which they are to surround. The problem now is to make the less contain the greater, which might well seem an Euclidian impossibility.

But the engineer brings the persuasive force of heat to bear on the less. The tire is carefully heated until the heat has brought about its expansion to a diameter large enough to encircle the wooden centre. As soon as this is the case the tire is laid on a steel table and the wheel, with its axle, which has meantime been slung ready for the operation, is carefully lowered into the hot but rapidly cooling tire. As soon as it is completely home, the whole is plunged into cold water, when the hissing, smoking tire rapidly contracts and clasps the wheel in a close embrace.

Wheels built on the foregoing lines are almost universally in use under British passenger stock, although in America they are rarely used, American engineers preferring either the Allen paper wheel or the Krupp wheel with its solid steel disc. Thus, while generally speaking, the American bogie frames are of wood and the wheels of steel, in Great Britain the reverse is the case, the wheels being of wood and the frames of steel. The diameter of wheels used in passenger service presents, too, some diversities in practice. As a rule the English carriage wheel is the largest in the world with a diameter practically standardised at 3 feet 6 inches. American wheels have been much smaller, many in service being not more than 2 feet 6 inches. In this respect practice on the continent of Europe has been very similar to the American, one of the few instances in which European and American practice agrees as against the British.

American roads are, however, beginning to recognise

that a 2 foot 6 inch wheel is too small for fast traffic and that a larger wheel is less liable to run hot. The Pullman Company, as might be expected, have been, in a way, the pioneers of this movement, and have adopted a 3 foot 2 inch wheel as their standard. Parallel with this alteration in America has been a similar increase in Europe, initiated by the International Sleeping Car Company.

We have now studied together some of the means adopted to carry the fortunate railway traveller of to-day safely and comfortably on his journey. Or perhaps, to put it more exactly, we have looked at the foundations upon which his safety and comfort are to be built up. We have, I hope, learnt that comfort is not a matter merely of paint and upholstery, but that its beginnings lie a long way back, before the upholsterer's hammer has driven a single tack, or the paint shop has begun to grind the material for a single coat of priming. To a large extent out of sight, too often the wheels and springs and framing whose secrets we have been trying to unravel are out of mind also. We will, however, now remember them as the foundations upon which the interesting and often imposing superstructures of the car-builder's art are to be raised, to which superstructures we will now turn.

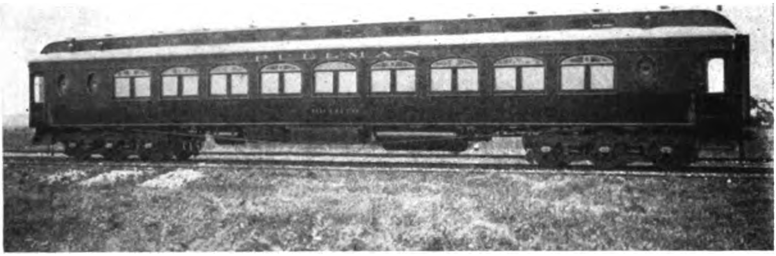

FIG. 21. PULLMAN DINING CAR "BRAZITO," SHOWING AMERICAN TYPE OF SIX-WHEELED TRUCK.

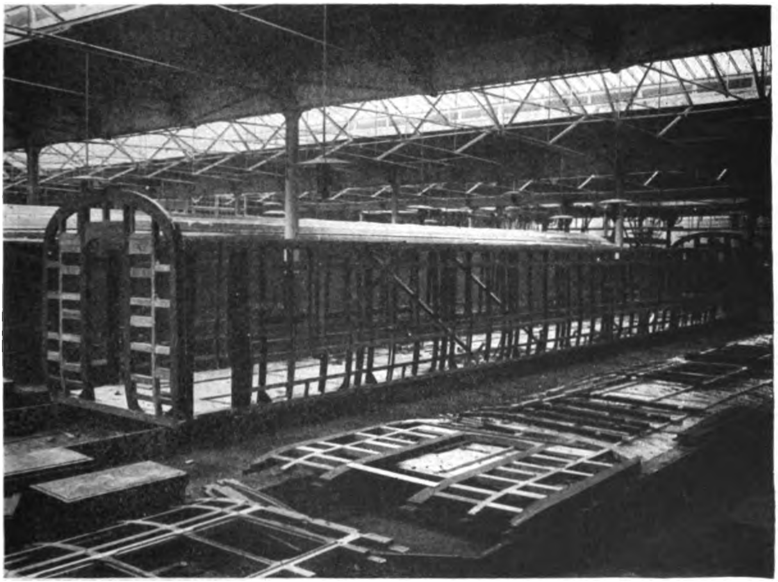

FIG. 23. THE BODY FRAME OF A GREAT WESTERN DINING CAR IN THE CARRIAGE SHOPS AT SWINDON.

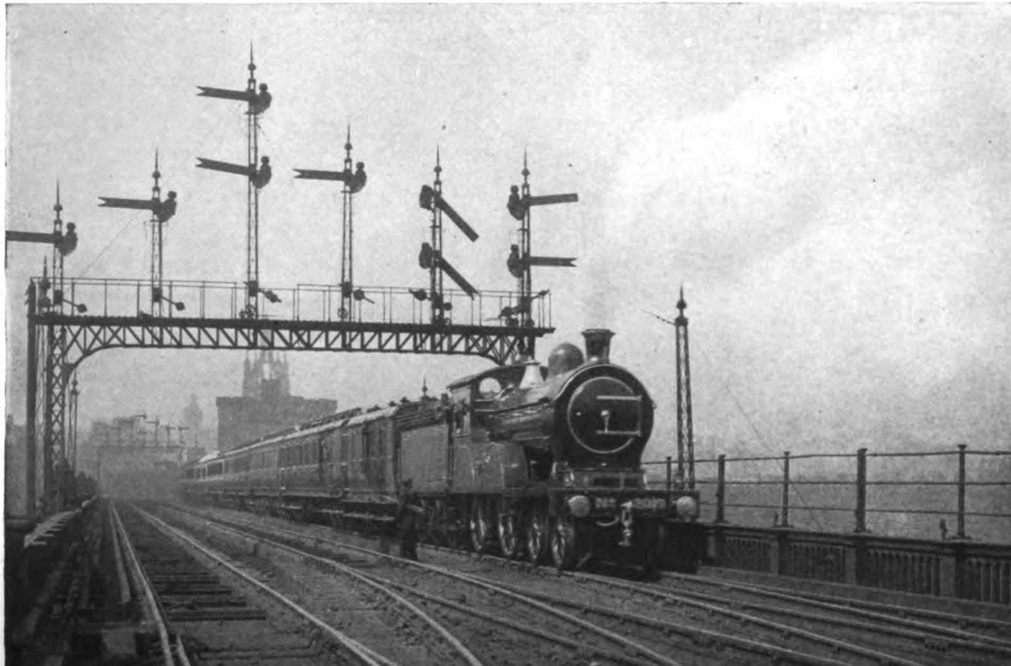

FIG. 22. A SOUTH-BOUND FLIER LEAVING NEWCASTLE. NORTH-EASTERN RAILWAY.

III

Car and Carriage Bodies

In the previous chapter we have traced the gradual development of the underframing and carrying gear of the railroad car up to the majestic twelve-wheelers of to-day. In the present one I want to try and trace the really striking way in which two opposing ideas have come into conflict and, profoundly modifying one another, have resulted in the production of a body which seems to present the perfection of convenience and comfort. These two opposing ideas we will call the ideas of carriage and car respectively. In our first chapter we saw that the body of a railway carriage consisted at first of a single coach body. This grew, by a process of accretion, into the long carriage with many compartments, but at the same time another and more profound development rapidly issued in the railway car.

Historically, the carriage is the older of the two types of vehicle, so we will take it first: and moreover, in this way we shall be able to trace the gradual invasion of the carriage design by the idea of the car. For, as I expect my readers are aware, these two ideas have had in the past a geographical significance, so that "car" has come to be an American synonym for railway coach, just as "carriage" has been the British synonym. And one of the most interesting chapters in the history of railroading has been the interaction of these two upon one another's design.

The carriage, then, consists of a number of isolated

compartments joined together in one body upon one underframe. This is from what we may call the ideal point of view: from the point of view of construction it would be more accurate to say that a carriage consists of a body divided into several separate compartments by partitions running transversely from side to side. With the increasing length of underframes the number of these compartments is now considerable. At the same time the number of compartments has not increased in anything like the same ratio as the length of the carriage. This is due to the fact that the size of the compartment, especially its width between partitions, has been appreciably increased. At least this is the case with third-class compartments, which form the bulk of British passenger accommodation. It is not so marked a feature in the higher classes. We may take this dimension, the width between partitions, at an average of 6 feet for modern British main line thirds. Not so very long ago 5 feet 6 inches, or even less, would have been nearer the mark for all but the very best roads. This made a very uncomfortable vehicle to ride in when full, especially for people with long legs, and on long journeys the cramped position was very trying, while for a passenger at the far end of the compartment to reach the door when the train stopped at a station was frequently a physical impossibility until all the other people in the compartment had stood up to make a passage. The modern dimension of 6 feet has made all the difference between comfort and discomfort in this respect, while the 6 feet 6 inches afforded by the newest Midland or London and North Western thirds is really spacious.

All this will give my readers an idea of the reason why the compartment carriage has been so popular with railway companies in England and Europe generally. It

is because the compartment system affords the most complete method available of utilising floor space, and that, consequently, compartment carriages carry a larger number of passengers in proportion to their tire weight, than those arranged on any other plan. A four-wheeled second- or third-class carriage, with five compartments each 5 feet 6 inches wide, will measure 27 feet 6 inches over the body and weigh about 10 tons. Such a carriage will seat 50 passengers, or a ratio of seats to tonnage of 5 to 1. Older vehicles might perhaps weigh not more than 8 tons, giving a ratio of 6.25. The 6-wheel third with six 6-foot compartments will weigh not less than 15 tons and only seat 60 passengers, involving a drop in the ratio to 4. And on many of the best English roads the 6-wheeled third has only accommodated 50 passengers in five compartments, thus involving a still further loss.

Tempting, therefore, as it is for a railway manager to try to herd his third-class passengers together as closely as possible in order to reduce the weight of his trains, we find that under stress of competition his plans have been profoundly modified. Even the lines serving the south of England, such as the London, Brighton and South Coast and South Eastern and Chatham, have, of late years, definitely abandoned their old policy of trying to force passengers into the higher classes by making the third class as uncomfortable as possible. How short-sighted this policy was, is apparent from the fact the despised third-class passenger never accounted for much less than 80 per cent. of the total passenger receipts, while, taking Great Britain as a whole, more than 90 per cent. of all passengers have for years travelled by the cheapest class.

In a similar way we might show that for first- and sec-

ond-class passengers the compartment carriage is still the most economical pattern of vehicle in service, and this fact explains the persistence of the type.

So much for the point of view of the railway manager. But what about the passenger? Which does he prefer? It seems difficult for writers, whether English or American, to approach this part of the subject without bias, both being, as a rule, equally convinced that the methods of their respective countries are the best. Some very one-sided statements have been the result of this state of mind. It is, however, I hope, possible for us to try to estimate fairly the merits and demerits of the compartment carriage, giving to both English and American design their due meed of praise and criticism.

As a traveller then, and fond of fresh air, I will begin by saying that on the whole you will get more fresh air and less draught in an English compartment than in an American car. Another advantage is that, given a party of adequate size, it is usually possible on most English lines to get a compartment reserved if reasonable notice is given. This secures the privacy so dear to the heart of the true Briton. When we have said this, however, we have, I fear, exhausted the merits of the isolated compartment. The fresh air supply disappears when the compartment has to be shared with some one who must have both windows up. And the privacy is apt to be too private when a passenger finds himself, or still more, herself, shut up for a long run of an hour or two's duration with some stranger who may prove to be drunk, or a thief or murderer or madman. These things have happened and will happen again. Engineers have done what they can by alarm apparatus of various kinds to minimise such dangers, but they undoubtedly exist. Then, too, there is the risk of a passenger falling

out of a compartment through the door being insufficiently secured. British railway records contain several fatal cases of this kind of accident happening.

The compartment, then, is lonely and dangerous. It is also, as we have already seen, extremely tiring for a long journey. The car affords the comfort of being able to move about, to take a little walk, and, perhaps most of all, to get a wash, on the journey, and in this respect is greatly superior to the compartment carriage. Moreover, though dining carriages have been run in England on trains otherwise made up of compartment coaches, their usefulness is greatly restricted as the only means of getting to the dining-car in such a case is by changing at a station.

So far, then, our verdict seems to be emphatically in favour of the car rather than the carriage from the passenger's point of view. But the car has two or three chief demerits which ought also to be set down. It is usually either very stuffy or draughty, sometimes both, and it is inconvenient as providing only two exits, as compared with the sixteen or eighteen of a long compartment coach. It is evident, therefore, that we cannot look upon either compartment carriage or open car as the final word in railway coach design. That final word has been left for English engineers to speak, and it began to be uttered when the first corridor coach made its appearance. We have already studied together in Chapter II., a fine first-class corridor carriage built by the Gloucester Railway Carriage and Wagon Company for the East Coast route. Third-class corridor vehicles first appeared in the same service in 1889.

The idea of providing some lavatory accommodation for third-class passengers began to be agitated about that time and the Midland, true to its third-class traditions,

was early in the field with carriages on the ordinary English compartment plan, but with lavatory compartments sandwiched in between. It was, however, the bold forward step of the Great Northern which gave England, and indeed all Europe, the type of coach which is by far the most convenient and comfortable that has yet been designed, and which was yet made available for the lowest class of passengers. I well remember visiting the Great Northern's Doncaster shops and climbing up into the first of the vehicles which were to work such a revolution in the railway passenger business. It was being built, as I have said, for service in the Scotch express trains, and coaches of the same type were soon running on all the company's crack services.

The design secures the privacy and ease of ventilation of the ordinary compartment, while at the same time the safety and convenience of the open car are attained, shorn of their attendant disadvantages. There is usually a door to each compartment, though often, on the corridor side of the coach, one door serves two compartments. These vehicles are now of all sizes and, on most English main line services, are now usually vestibuled. The picture in Figure 22 shows a south-bound East Coast day Scotch express pulling out of Newcastle Central, North Eastern Railway, on the 88-mile run to York. The photograph was taken just at the south end of Stephenson's famous high-level bridge across the Tyne and shows the open work spire of Newcastle cathedral towering up behind the signal gantry. The first coach of the train is a Great Northern six-wheeled brake van with that company's typical type of rounded roof. Then follow the big twelve-wheeled vestibuled corridor cars of the East Coast Joint Stock, owned jointly by the Great Northern, North Eastern

and North British. The second of these cars has a peculiar look owing to the bulge of the sides. It is a third-class dining-car of which several were built with this costly, and it must be owned very ugly, contour in order to provide increased elbow-room at the level of the tables. The engine is one of Mr. Worsdell's handsome 4-4-0 passenger locomotives with 6 feet 10 inch drivers. The Anglo-Scottish services are to British railways very much what the New York-Chicago services are to the American roads; and the history of the corridor car is one instance of how worthily the companies forming the East Coast route have taken their share in the strenuous competition.

The timing, sad to say, presents just now another story of deceleration, but I append the log of the best East Coast train at present running between the English and Scottish capitals.

EAST COAST RESTAURANT SLEEPING CAR EXPRESS

STATIONS		Time	Miles from London	Miles from previous stop	Average speed between stops
		P. M.			
London (King's Cross)	dep.	8.25	......	......	......
Grantham	arr.	10.27	105.25	105.25	51.76
	dep.	10.32	......	......	......
		A. M.			
York	arr.	12.03	1.81	75.75	49.96
	dep.	12.10	......	......	......
Newcastle	arr.	1.41	268.50	87.50	57.69
	dep.	1.46		......	......
Edinburgh (Waverley)	arr.	4.16	393.00	124.50	49.80

This table, though a falling off from former glory, is still very good, the timing for the last section, Newcastle to Edinburgh, being better than it looks. The line climbs

high over the Northumbrian moors and Lammermuir hills and there is a long slack over the Border Bridge and through the cramped station of Berwick on Tweed, where the train enters on the North British main line. There are not many more beautiful sights than to see the grey dawn of a summer morning first begin to push aside the blinds of your sleeper as the train goes racing seawards through sleeping Morpeth, or a little further on past Alnmouth to see the sun rays flashing over the edge of the North Sea. As your train swings rumbling across the Tweed, brown-sailed boats are creeping in from the night's fishing and the wild dash down the beautiful "Copper's Pass" is sufficient to banish sleep from all but the most satiated travellers.

The arrival time at Edinburgh is distinctly uncomfortable, but I ought to add that this train is really hardly intended for Edinburgh passengers. The sleepers go on to Aberdeen, and on certain nights of the week, to Perth and Inverness. For Edinburgh passengers there is the almost equally good 11.30 P. M. due at 7.30 A. M., but I chose the earlier train for our record on account of its nine minutes quicker timing.

From the general considerations as to the interaction of the ideas of car and carriage resulting in the production of the corridor compartment car we have now to turn to examine the underlying design upon which carriages and cars are respectively built. The differences between the two are noteworthy, the most important, as usual, lying out of sight. This is the arrangement of the body framing, which is, of course, covered up by panelling both inside and out. The framing of the ordinary English compartment carriage is, as a rule, square. This is necessitated by the numerous side doors, which prevent

the introduction of braces or trusses into the frame to any great extent. Two at least of the British roads have, however, built their main line corridor coaches with a certain amount of trussing squeezed into the body frames. The two lines to which I refer are the London & North Western and the Great Central.

The accompanying picture of the body framing of a Great Western dining-car shows a fairly typical English design. The photograph was taken in the body shop at Swindon, and we are indebted for it to Mr. Churchward's kindness. The cross-pieces visible in the picture between the two sides of the coach are merely temporary supports put in to hold the unfinished framing in position. It will be noticed that all the joints in the frame are right-angled, and there is consequently nothing but the accurate fit of the joints, reinforced by small iron knees at regular intervals, to prevent the whole structure from racking under the strains imposed by the starting and stopping of the coach when in service.

The lowermost members of the body framing are the bottom sides, running longitudinally, and the end bars, partition bars and intermediate bars, running transversely and fitting tightly into mortices prepared for their reception in the bottom sides. Iron knees are fitted at the four corners of this framing, at the junctions of bottom sides with end bars, to assist in keeping the whole thoroughly true and square. The next members of the body frame to be noticed are corner pillars—stout pieces of wood mortised into the bottom sides at the four corners of the carriage. In the usual English compartment carriage the door pillars need to be almost as strong, but the picture before us represents the framing of a restaurant car, and it is, of course, only necessary

in such a vehicle to provide doors near either end of the car. The thickness of the pillars for this service may be easily judged from the photograph.

The longitudinal members of the body frame are termed "rails." Our picture shows us five of these rails, of which, to name them in order from the bottom upwards, the lowermost one is termed the "bottom rail." Next comes the "waist rail," to which, as well as to the bottom rail and bottom side, will presently be attached the bottom panel, which will ultimately bear on its glossy surface the company's initials and coat of arms. Above the waist rail we have the "bottom light rail." The interval between these two members will be spanned by the waist panel, upon which the finished coach usually bears its running number and class designation. Then, mounting upwards, we come to the "quarter light rail." The occurrence of the word "light" in the names of these two last members is due to the fact that they enclose between them the windows, or lights, as they are technically called. In England the side lights are invariably fixed and immovable, though the door windows are always arranged in the form of a drop sash; but on the continent of Europe and still more in very hot countries, where compartment vehicles are in use, such side windows are frequently made to open.

The last and topmost rail of the frame is the "cant rail." The upper edge of this rail is bevelled to the curve of the roof and upon it rest the roof sticks or carlines, as they are called in America. The end framing does not call for particular notice. My readers will observe, however, that, in the vehicle under consideration stout doorposts are provided for the vestibule, or more properly, covered gangway, with which it is to be fitted. The disposition of the various cross-pieces in the end framing

must be, to some extent, directed by the position which is to be occupied by the ascending rail and steps by which the station porters may climb to the roof, when necessary, for such operations as lighting gas lamps or filling water tanks.

The only other point concerning the body frame of English passenger stock that seems to call for remark is the turn under, as it is called, given to the sides, and often to the ends as well. British carriage builders have always had an affection for large curved and bulged panels, and the glassy sheen reflected from the bright surface of a well kept passenger coach is certainly attractive. The first corridor train with side gangways put into service on the Great Western in 1892 represented this typically British method in the height of extravagance. Not only had each coach the customary turn under at sides and ends, but the bottom and waist panels were also bulged out as widely as possible between each pair of compartments in order to afford additional elbow room. The doors and door handles were of the then standard pattern, and, of course, they with their frames had to be kept straight, but the rest of the area of the coach sides presented a series of protuberances resembling in contour a Sudanese shield, and, shining in the smart Great Western cream and chocolate, presented an almost comical appearance.

The English body frame is hoisted on to its underframe by means of jacks, and rubber blocks are usually provided upon which the former may rest. In the American pattern of car, on the other hand, the body and under frames are essentially one. The main members of the body frame, which are not the pillars as in the English type, are built upon and mortised into the timbers of the underframe itself. I have said the main members of the

American body frame are not the pillars: there are pillars of course—"posts" is the American technical term—between each window and also corner and door posts at the ends of the car. But the chief members of the American car frame are the great compression beam braces and compression beam, which, with the auxiliary compression beam braces and counter braces constitute the lower half of the body frame a veritable truss. Of course the full benefit of this trussing begins to go so soon as ever you start to cut doorways in the car sides, but, if the designer confines himself to end doors, he is able, by the adoption of this truss form, to make his car into a fortress of longitudinal strength.

What this may mean was strikingly illustrated in a bad wreck at Thirsk, in Yorkshire, on the 2nd November, 1892. Ten people were killed and several injured, but one of the coaches was an eight-wheeled Pullman sleeper, the "India," whose massive truss frame proved truly an ark of safety both to the passengers in the car and also to those in the carriages behind. All the deaths and serious injuries occurred in front of the Pullman. In and behind it, passengers escaped with a shaking. Facts like these go to show what an immense advantage the American pattern of car has over the compartment carriage, not only in comfort, but in the even more important matter of safety. As we have already seen, English railways are now beginning to introduce trussing into their corridor carriages, as far as possible, though the strength of the trussing continues to be seriously impaired when the side doors are still used.

The interior arrangements of a coach of course vary greatly with the different types of framing. As a typical American interior we may take the annexed picture of a first-class car for the Illinois Central. The American

first-class, it should be noted, is roughly equivalent to the English third-class, with, roughly, three modifications. First of all the American fare, especially out West, is frequently rather higher than the English penny per mile. Secondly, on many lines, the best expresses do not carry coaches at ordinary fares. This is more particularly true of the Eastern States where, however, the two cent or one penny per mile is the standard rate. In these two points the English third-class traveller undoubtedly scores. The fare never exceeds the legal penny and is frequently below it, and third-class cars are run on all the best trains. The only exceptions to this last point are certain of the London, Brighton and South Coast trains, some of the boat trains of the South Eastern & Chatham and Great Eastern lines. In this last case, however, the second-class fares are really lower than the legal third-class rate, though not, of course, lower than the actual rate for the cheaper class.

The third modification of the substantial equality of position I have just mentioned is distinctly in favour of the American traveller. I mean the fact that both classes of sleeping-car service, the Pullman and the so-called Tourist, are both generally open to the ordinary ticket holder. The reform in this matter which would make the English service equal to the American would be the introduction of third-class sleepers, a reform often agitated, often rumoured to be about to take effect, but never yet seen. If I may be so rash as to venture upon a prophecy, the day will come before long when, either in the glory of the Midland red, or in the business-like varnished teak of the East Coast, the first third-class sleeper, with every berth occupied, will run from London to Edinburgh or Glasgow. Another point which some of my readers might be inclined to hold as favouring the

American is the fact that America has only one class of dining-car, while in England the third-class passenger is usually relegated to the third-class diner. But the English third-class dining-car is uniformly so excellent, as we shall see later, that I do not think this counts either way.

Now to return to our picture after this long digression. The interior illustrated is that of a standard day car, which is nevertheless a little more elegantly finished than the ordinary pattern in use on the Illinois Central. It shows, in fact, the type of coach intended for service on the crack expresses of the road, such as the Chicago-Omaha Limited and the New Orleans Special. My readers will note that the Illinois Central runs these first-class coaches even on its best trains. At right angles to the general course of American railroad building, which has been from east to west, the main line of the Illinois Central runs from north to south. The road has far outgrown by this time the State from which it takes its name, and its track now stretches from Chicago, where the great lake docks are sealed by ice for months in the year, along the Mississippi valley to the swamps and cotton fields of the South, finally ending on the broad levees of New Orleans, the second port of the United States. Practically the whole of this 922.65 miles of railway is double track, and though we cannot expect to find the speed records here that we have on the eastern roads, yet the train service is really good. The New Orleans Special takes 25½ hours to cover the distance between the two termini, an average speed, including stops, of 36.18 miles an hour. When I add that there are no less than twenty-six conditional stops, in addition to the thirty-eight regular ones on the schedule, my readers will see that this represents very meritorious locomotive work.

Fig. 24.

Fig. 25.

Interiors, East and West.

Fig. 24. Illinois Central Railroad.
Fig. 25. Ottoman Railway.

The principal feature in the interior design of the car, beyond its general roominess, is the dome deck roof. This adds most pleasingly to the appearance of the car and provides, at the same time, a very effective ventilating device.

Our next picture takes us rather to the other end of the world, and certainly to the other end of the scale so far as conditions of travel are concerned. It shows us an interior view of the third-class portion of a composite, first- and third-class car for the Ottoman Railway. We have already seen an exterior view of a similar car, in Figure No. 16; the present car is identical in size and general design with the former, and comes from the shops of the same builders. It differs only in being divided by a cross partition in the centre of the car into two different classes. Through the open door in this partition we can get a glimpse into the first-class portion with its leather-covered seats. These, like the seats in most American cars, are of the walk over type, that is to say, the backs can be swung from one side of the seat to the other, so that the passenger can sit facing which way he likes. The backs in this pattern seat are of course upholstered on both sides.

In the third-class compartment, where our picture is taken, the seats are fixed and consist only of plain varnished slats of wood, much as in an ordinary garden seat. The car has a plain, rounded, single-deck roof, fitted with what are called torpedo ventilators and lighted by electricity. Notice the lowering windows and lowered wooden sun blinds, also the economical continuous parcel rack of stamped tin.

British railways have not, as a rule, adopted the real American type of open car, preferring the added comforts of the corridor. But one of the nearest approaches

to definite American practice has been made by the South Eastern & Chatham Railway. Mr. W. S. Wainwright, the company's locomotive and carriage superintendent, designed the cars to which I refer, and they were built at the company's works at Ashford, Kent. They have trussed body frames, very much like the usual American type, and have Gould automatic couplers and vestibules. Two trains were put into service in 1898, one running between London and Folkestone and the other between London, Tunbridge-Wells and Hastings. These cars are beautifully finished and decorated, both without and within. The bodies measure each 50 feet long and 8 feet 6 inches wide, the length over vestibule face plates being 57 feet 6 inches. They each run on two four-wheeled, steel-framed bogies and are equipped with automatic vacuum brake, steam heat and electric light.

Our picture gives us a view of the interior of a third-class car. The second-class are identical with the thirds except in colour of upholstery and some small decorative details. From the picture my readers will see several departures from standard American practice. In the first place seating room is only given for three passengers abreast instead of four. This is due to the comparative narrowness of the car body. In the next place the seats are fixed after the plan of the ordinary English compartment carriage. There is a smoking-room at one end of the car and each car is provided with lavatory accommodation. The best train carrying this accommodation leaves London, Cannon Street station, at 4.33 P. M., and runs without a stop to Folkestone Central, where it arrives at 6.02; just 89 minutes for 71 miles, a speed of 47.86 miles an hour. The speed is not heroic, but there is a tangle of junctions before the train gets clear of

London and a fair amount of collar work for the first fifteen miles or so.

Having now glanced at some typical examples of the open or American type of car, whose essential feature is an aisle running down the centre, let us now turn to look at a fine specimen of a British corridor car. The great advantages of this type over the open car will be evident to all who have ever seen the two. For any of my readers whose practical acquaintance is limited to either one of the two I hope our pictures will help to bring home the distinctive features. I have already mentioned one weakness of the corridor car as compared with the open type, and that is the structural weakness caused by the door openings. That, however, might be avoided. There is no real reason why so many doors should be provided. If only the corridor can be built fairly wide, with easy turns at either end of the car by the doors, the rapidity of exit is not much affected. Experiments actually carried out by the Lancashire & Yorkshire Railway at their big terminus in Liverpool show that a car with only end doors can be emptied of passengers, even when crowded, in less than one minute. We will refer to this experiment again when we come to discuss suburban traffic. For the present I only want to plead for the adoption of a true corridor car, with end doors and good wide vestibules. The abolition of all side doors with their handles would add inches to the width available inside the car, besides enabling the body to be strengthened. I ought, perhaps, to add here, though it is anticipating a little, that this type of car is already running, in Great Britain in the sleeping cars of the various companies, and in America in the Pullman compartment sleepers, while somewhat similar vehicles to

these last are run in Europe by the International Sleeping Car Company.

Another defect of the corridor car is the difficulty of accurately balancing it. The corridor side of the coach, being mostly unoccupied, of course carries much less weight than the opposite side. Cars have been built with a zigzag corridor to try and get over this difficulty. The passage in this case crosses over from one side of the car to the other at about the middle of its length. This gives good results, but wastes space in the most easy riding and valuable part of the vehicle. Various English lines have put into service a good many semi-corridor carriages, not cars, built on these lines. These are usually composites, in which case the first-class compartments open into one corridor while those of the second or third class, as the case may be, open into the other. Each corridor leads to a lavatory compartment in the centre of the coach. These compartments are the two halves of a full-sized compartment cut right in half by a partition extending to the roof. My readers will remember a carriage of this type for the Paris Orleans Railway illustrated in Figure No. 11.

The subject of our present illustration is, however, a proper corridor car, having, as a matter of fact, vestibule connections, though these are not visible from the point of view of our picture. This car is a third-class coach, running on two four-wheeled bogies and weighing about twenty-five tons. Like all the new Midland stock, it is remarkable for the lightness and airiness of its interior. Notice the size of the windows and the substitution of glass for the usual wooden upper panels. The loftiness of the corridor is a feature which will appeal to some who have had to walk with bent head and downcast eyes through the side passageways of the pas-

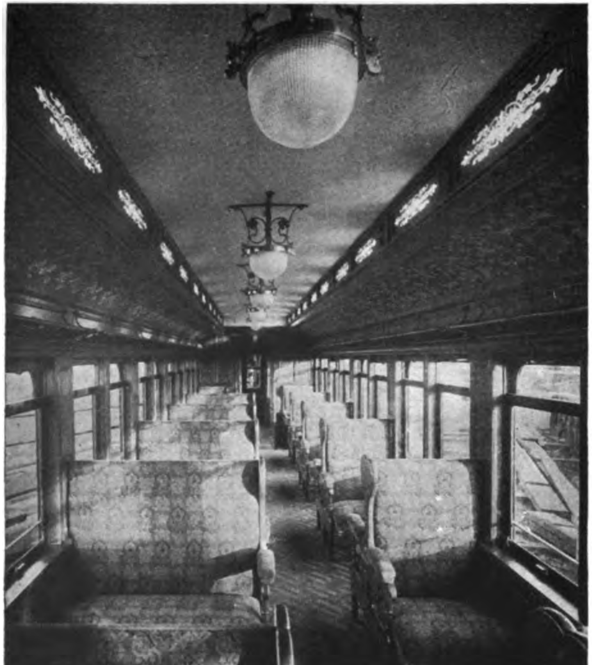

Fig. 26.

Fig. 27.

Two English Interiors.

Fig. 26. South-eastern and Chatham Railway.
Fig. 27. View down a Midland Corridor.

senger coaches on some lines. The inner compartment doors are hinged. In most recent corridor stock they are made to slide, an arrangement which gives a little extra space in the corridor and is not so likely to foul luggage or passers by. In many cars, too, hinged flap seats are provided at intervals along the corridor, so that a passenger who wants a change can go and sit out there.

I have already referred to the liberal dimensions of the Midland third-class compartments. The whole interior is planned, upholstered and decorated in a most comfortable and attractive style. These cars, like all the Midland main line stock, have lofty clerestorys in their roofs, the whole of the clerestory being, as usual, thrown into the compartment. The corridor gives us a good idea of a feature of British carriage building I have already mentioned in this chapter. I mean the turn under of the sides. It is costly, and, it must be confessed, to lay eyes appears very useless. The car is lighted, as our picture shows us, by Pintsch's gas, and steam heated. One heating pipe may be seen running along the corridor floor.

It has become a very frequent practice now to place either carpet or linoleum on the floors of cars and carriages. The corridor in our picture is laid with linoleum, and so are the compartments, at least in the space between the seats. Floor coverings were first adopted in English first-class carriages and American Pullmans for the sake of the greater comfort they give, but their use has an important constructional effect in reducing the wear of the floor boards. It is much cheaper to renew linoleum than to take out old floor boards and replace them by new ones, especially when, as is often the case in England, the floor boards are laid diagonally across the frame.

Turning now from the interior of our corridor, let us

just glance for a moment at the exterior of such a vehicle. For an example of this I have chosen a first- and second-class composite coach for the London & South Western Railway. This car was built at the company's shops at Eastleigh for the west of England express services. The company's best trains to Exeter and Plymouth now have dining-cars attached which has necessitated the adoption of vestibuled coaches for these trains. The London & South Western's standard practice, however, embraces neither vestibules nor corridors, most of their trains being made up of ordinary English compartment carriages with a good percentage of lavatory accommodation divided among all three classes. The coach illustrated is therefore exceptional, though all the company's modern main line and suburban stock conforms to the same general dimensions and outline.

The row of black objects along the roof consists of torpedo ventilators. This simple but effective device is so arranged that the used-up air is withdrawn from the compartment by the rush of wind outside as the train sweeps along. The inside walls of the corridor are lined with plain white lincrusta, as may be plainly seen in our photograph, this being about the best material possible for imparting a sense of lightness to the interior. The pattern of vestibule employed can also be seen from the picture. The general design of it is more or less common to most British lines. The automatic vacuum brake, steam head and the usual screw couplings and side buffers are provided. It seems a pity not to replace the last two items by automatic couplers on all vestibuled stock. The tediousness and difficulty of operating the ordinary English shackle and screw arrangement is considerably increased when a pair of connecting vestibules comes in the way.

Hitherto we have been thinking of railway carriages and cars as units, but the mention of vestibules brings us to another point of view in which the individual coach is not a unit, but a fraction, the unit being the train itself. And the London & South Western is also appropriate in this connection, because they, more than any other English road, have grasped this idea and made it the basis of their working arrangements. The old custom of breaking up a train after it had reached its destination and remarshalling its carriages into other trains, is now largely given up. Coaches are now more than ever built with a view to being members of a train, and when a trip is finished it is the train that is shunted, or switched, as a whole, and after being cleaned up is put on a side track until required for duty again.

The London & South Western trains are now nearly all numbered, big white figures to designate the train being printed on the ends of the front and rear coaches, and small white figures stencilling the same number on the solebars of each carriage. This plan greatly facilitates the working of the operating departments of the road, by reducing the number of units with which they have to deal. Extra coaches must of course still be provided to be added to the regular trains in time of pressure.

The practice of numbering trains began, in England, with the block trains for suburban traffic. These block trains, as they are called, consist usually of close-coupled carriages with very short side buffers and connected together by a pin dropped through eyes projecting from the head stocks. Afterwards when vestibuled trains were introduced for various services they naturally were looked upon as a class apart and the London & South Western have only carried the idea to its logical conclusion. Since then other roads have begun to adopt a similar practice,

and except where working is complicated by the running of a large number of through carriages to widely scattered destinations on the same train, the plan bids fair to become almost universal. This through carriage, by the way, is an institution very dear to the heart of the English traveller. The saving of trouble and expense is immense, especially as he has not yet quite learned to hand over his luggage to the railway company, and English lines go to a great deal of trouble in catering for cross-country journeys. One random instance of this occurs to me as I write. The 5:30 P. M. express on the Great Eastern Railway only runs from London, Liverpool Street, to Ipswich, a distance of 68¾ miles. Yet that train leaves London frequently with eighteen or nineteen coaches and arrives at its destination with eight or nine, having scattered the rest far and wide over Essex during its journey of two hours and four minutes. And British time-tables are full of striking instances of the daily journey of through coaches, often by devious routes, from north to south and from east to west of the island.

Well, in cases like this, the train unit idea becomes less practicable and the carriage becomes once again a more or less self-contained unit. And it requires no little ingenuity, as my readers may judge, to squeeze what are, including smoking and non-smoking compartments, practically six classes, each with lavatory accommodation, and a fair-sized luggage cupboard, or perhaps guard's compartment, within the limits of a 50-foot coach. Our next picture shows how it is done. This is a tri-composite corridor vestibule coach built by the South Eastern & Chatham Railway for such through traffic. Tri-composite, or tri-compo, as the railway phrase goes, means of course a carriage having compart-

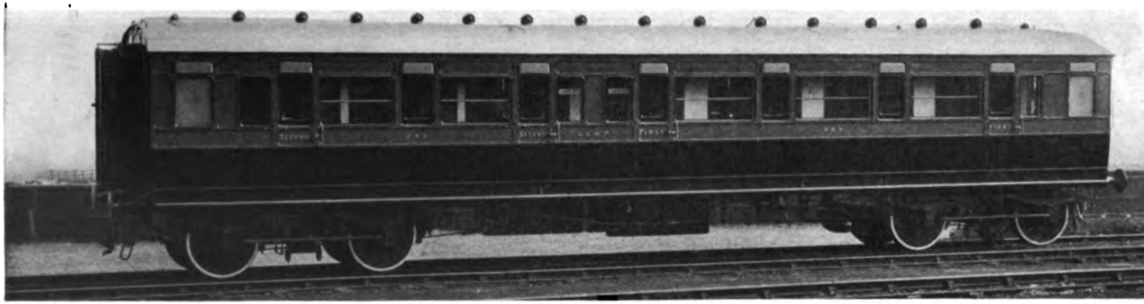

FIG. 28. LONDON AND SOUTH-WESTERN RAILWAY.

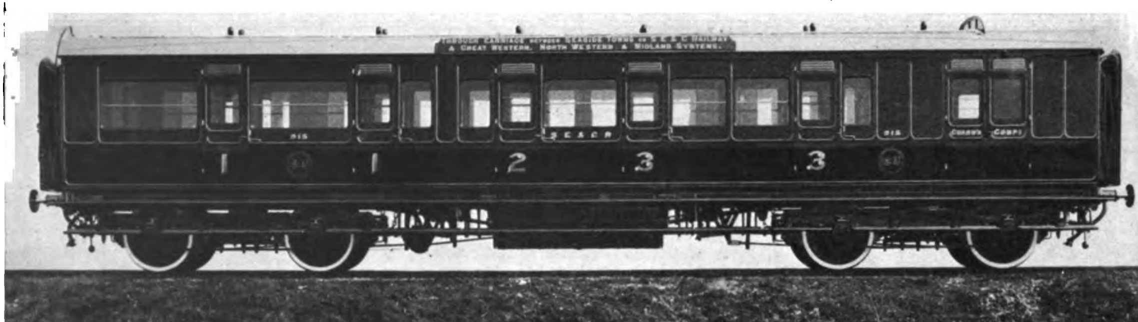

FIG. 29. SOUTH-EASTERN AND CHATHAM RAILWAY.
ENGLISH BOGIE VESTIBULED COMPARTMENT COACHES.

ments for all three classes. The large guard's compartment provided has prevented the provision of a second-class smoking compartment, but the space allotted is none too much for the quantity of luggage that the through guard has under his care. Coaches of this description run between some of the Kentish coast towns, Deal, Dover and Folkestone, and the great business centres of the north, such as Leicester, Nottingham, Derby, Manchester (Central Station), Leeds, and Bradford on the Midland; and Rugby, Crewe, Stockport, and Manchester (London Road Station) on the London & North Western. The Great Western also hands over daily to the South Eastern at Reading a through train which has come all the way from Birkenhead, together with a Great Central coach from Manchester.

All this enterprise and energy on the part of the roads concerned has resulted in the creation of a growing volume of profitable traffic, which probably but for the stimulus thus afforded would never have spread itself so far from its source. The carriage illustrated has two lavatories, one at the first-class end, the other squeezed between the two third-class compartments. The vestibuled connections allow it to be connected to the trains on the London & North Western or Midland on which dining-cars are being run. The coaches measure 50 feet 1 inch long over body, by 8 feet wide. The first-class compartments are 7 feet 2 inches long, the second 6 feet 4 inches, and the thirds 5 feet 7 and 5-10 inches. The compartments are 7 feet 5 inches in height from roof to floor, and the top of the guard's lookout is 12 feet 6 inches from the rail level. The corridor is 2 feet 1 inch wide. The underframe and bogies are built of steel throughout, the body frame being of teak with mahogany panels. Ac-

commodation is provided for twenty-six passengers in all. The chief criticism to be passed is the extreme narrowness of the coach. This has been adopted because of a restriction in the loading gauge of the swing bridge over the Stour between Minster and Sandwich, and though these coaches are not intended to travel over that section, yet restrictions on the running of a carriage are always inconvenient where they can be avoided. I have described this carriage somewhat fully because it happens to illustrate rather well a distinctive feature of English railway practice, and which we may perhaps describe as the attempt to squeeze a train into a carriage.

Now, to go back after this digression, in America trains began to show evidences of this unifying process, when trains consisting entirely of Pullman or Wagner cars began to be built. It soon became quite the custom to paint the name of the train on the cars, as well as of the owning or operating company. The car already illustrated for the Empire State Express forms a case in point. One of the earliest instances of this was perhaps the famous "Pennsylvania Limited."[1] This train was the outcome of Mr. Pullman's introduction of the vestibule, and it is this special feature of the car or coach body of to-day that I want to speak about in concluding this chapter.

The usual form of American car, prior to the invention of the vestibule, terminated in a platform at either end from which platform steps led down to the ground. Access was thus perfectly possible from one car to the next across this platform which was protected at the sides by low iron gates. But to cross from one car to another while the train was running over a possibly not too well laid road was a distinctly hazardous performance, and many were the fatal accidents that happened

through passengers being thrown bodily overboard. Still, foolhardy folks would persist in making the venture, and as the doors could not be kept locked the roads could only try to deter passengers by threats. One such threat deserves perhaps to be recorded. It was perpetrated by a company in New Jersey and consisted in painting on the inside of each door of its cars a great tombstone with the inscription, "Sacred to the Memory of the Man who stood on the Platform."

But with the growing length of American rail journeys these restrictions began to be more than ever objectionable. Dining-cars began running, and if they were to be profitable passengers must be encouraged to do what hitherto had been forbidden. It had been evident for some years that some attempt must be made to get over the difficulty, and various devices were patented. Even as early as 1857 the Naugatuck Railroad, in Connecticut, now part of the New York, New Haven & Hartford Railroad, began fitting sheets of canvas to form a passage between adjoining cars. The idea of this invention was mainly to provide for taking in air at the head of the train and so enabling the car windows to be kept shut and keeping out the suffocating clouds of dust which an open window admitted. But this proved a failure and future attempts were not more successful for just thirty years. Then, in 1887, Mr. Pullman patented his famous vestibule, which really marked an era in car building.

The picture (Figure No. 30) shows the rear end of a vestibuled train on the Long Island Railroad. My readers will see the platform is quite enclosed; this is an improvement on the earlier pattern which left the steps outside the vestibule erection. The type illustrated is called the wide vestibule in distinction to the earlier one.

The vestibule consists of two steel frames, nearly oblong in shape, and joined together by stays which allow the other frame to move to a certain extent either towards or away from the inner. Spiral springs keep the two frames apart when the car is uncoupled. Of course, when another vestibule is brought up close to the first one, these springs are placed in a state of compression, which has the effect of holding the two outer frames, or face plates, firmly together. The springs and stays of each vestibule are covered by a sheeting of rubber or leather so that they are not visible in the pictures.

It will at once be seen that the Pullman vestibule not only provides for a safe passageway between cars, so bringing about the idea of the train unit, as I have already said, but it is also a safety appliance of untold value in the event of a wreck. Two cars so equipped are provided with what is practically a continuous buffer from floor to roof, and telescoping, that dreaded result of a railroad wreck, becomes impossible. The Pullman vestibule was one of those obvious things which, when they appear, cause folks to wonder why they were not thought of before. It was therefore not surprising that the idea should be immediately taken up and copied, more or less faithfully, all over the railway world. In Great Britain railways have mostly preferred to adopt a vestibule of their own individual design and choice. At first English builders could not even decide upon the position of their vestibule connections. Some lines built them in the centre, others at one side or another, with the result that you could sometimes see trains with coaches of which the vestibules would not connect. Now, however, the vestibule has established its proper position as being at the centre of the vehicle, though a good many mail vans are still running having vestibules

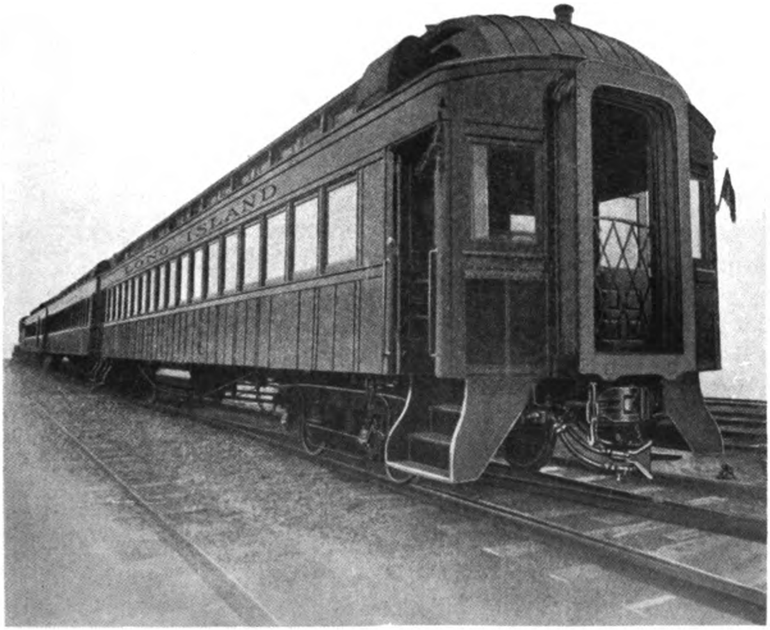

FIG. 30. REAR VIEW OF LONG ISLAND TRAIN, SHOWING AUTOMATIC AIR AND STEAM COUPLERS.

at one side. I should prefer to speak of these connections as gangways rather than vestibules. The British vestibule, properly so-called, is unfortunately not yet standardised. Both design and dimensions frequently vary, to the great detriment of the usefulness of the device, as when away from home, or on a foreign road as the railway phrase is, it may very well happen that a vestibuled coach of one company may be running in another company's vestibuled train without the possibility of connection being made between the vestibules.

Apart from the Pullman cars themselves, which now run only on the London, Brighton & South Coast, and London & South Western companies' roads, the only lines in England which have adopted the Pullman vestibule are the South Eastern & Chatham, in the particular trains already described, the Great Central and the Great Northern. To this last company really belongs the honour of introducing the vestibule into England. First the Anglo-Scottish East Coast expresses, and then their own chief main line trains, have been equipped with proper vestibules combined with Gould automatic couplers. This brings us to the consideration of some of the wide differences in methods of coupling cars and carriages together.

In Great Britain and on the continent the usual means of coupling used for passenger, and sometimes also for freight service, consists of two U-shaped shackles, each about nine inches long, connected by a right and left handed screw fifteen inches long. The ends of each U-shaped shackle are joined by a rod having a hole in the centre, threaded to receive the screw. Each coach carries one of these couplings at either end. One shackle of the coupling is usually fixed to the drawbar of its carriage with the coupling hanging as shown in the pic-

ture of the London & South Western carriage (Figure No. 28). To couple two carriages together on this plan, it is necessary for the operator to get down between the carriages and place the free end of one coupling into the drawhook of the coach next to it. To do this the coupling must of course be slack. It is made taut by revolving the long right and left handed screw. To enable this to be done, the screw is provided with a handle about sixteen inches long fixed about the centre of the screw. This handle is hinged and weighted with an iron ball at the end, so that when the operation is completed the handle is held in position by gravity and the screw is prevented from revolving, as it would otherwise do, and becoming disconnected from the shackles.

All this is tedious to describe and tedious to do. Moreover it is an operation by no means unattended by risk. The adoption of some kind of automatic coupler is therefore greatly to be wished. In America, where a link and pin was the usual form of coupling, the danger was so extreme, owing to the closeness of the car platforms one to another, that the use of an automatic coupler was enforced by law on and after 1st January, 1898. It is quite possible that similar legislation may be put into force in Great Britain before long and engineers have perfected several methods of coupling with such requirements, when they come about, but the great expense involved makes British lines hold back until such time as the change may become compulsory.

There are a good many various patterns of automatic coupler in use in America. The variations are, however, all controlled by the M. C. B. standards, and the different types all present practically the same general outline and are of course capable of free interchange. The general design was fixed so long ago as 1887. Sub-

sequent modifications, though often important, have only concerned details. Our picture of the Long Island train gives us a good idea of the appearance of the automatic coupler. It presents always the form of a hand held with the fingers crooked and turned to the left as you look towards the car with which the coupler will engage. The fingers, or knuckle, as it is technically called, of this iron band will turn inwards, but not outwards—beyond a certain limit. Consequently, when two couplers are pushed together the knuckles mutually turn in and slip past one another, then, by the peculiarity of their shape, they engage and hold tight. As this happens a steel block, called the knuckle lock, drops into place behind each knuckle and prevents them from unclosing. To uncouple the cars, this lock is pulled out by means of a lever and chain attached to the car platform. There is no need for any one to go between the cars, and the operation only takes a fraction of the time occupied in working the English screw coupling.

To adapt this idea to English needs, Messrs. W. S. Laycock Limited of Sheffield, have introduced an ingenious combination coupler. It consists of an American coupler, held on the end of a drawbar, equipped with an English drawhook, and when it becomes necessary to couple up an automatic with a shackle, or in other words a "coupler" with a "coupling," all that is required is to drop the coupler out of the way, leaving the drawhook exposed. This is done by withdrawing a stout steel pin which, when in position, holds the coupler in place.

The Long Island train in our picture is equipped with yet another automatic device. When car couplers had been provided, it was still necessary for men to go between cars to couple the brake hose and, in winter, the

steam heating hose as well. This last difficulty has been at last overcome by the introduction of the Westinghouse automatic air and steam coupler. This consists, as our picture shows, of an iron coupler head, to which the hose pipes are attached, and which is furnished with suitable springs and guides to engage with the fellow when coupling. The saving of time represented by this complete system of automatic coupling is enormous. The Long Island Railroad handles a very heavy suburban traffic, over the pleasant hundred miles or so of Long Island. At the rush hours of morning and evening, they are faced by the congestion at their terminals in Brooklyn and Long Island City, which that class of business brings with it in all the big cities of the world. With a view to getting trains away smartly, they have equipped their entire passenger stock, including locomotives, with this device and report marked improvement in timekeeping in consequence.

We will close this chapter with pictures of three trains illustrating the ideas and principles about which we have already learnt something, as they appear in actual work in three different countries. The first is one of the new vestibuled trains for the London & North Western's service between London, Euston and Manchester. This train consists of five corridor coaches, giving accommodation for first- second- and third-class passengers and ample baggage space. The cars are equipped throughout with the company's standard vestibule. The ends, as may be seen in the picture, are closed with a moveable shutter, according to the North Western's invariable and admirable practice. If it is required to add more cars to the train, the shutter is unhooked and carried in the guard's van. The usual projecting wings for guards' lookouts have been done away with in these

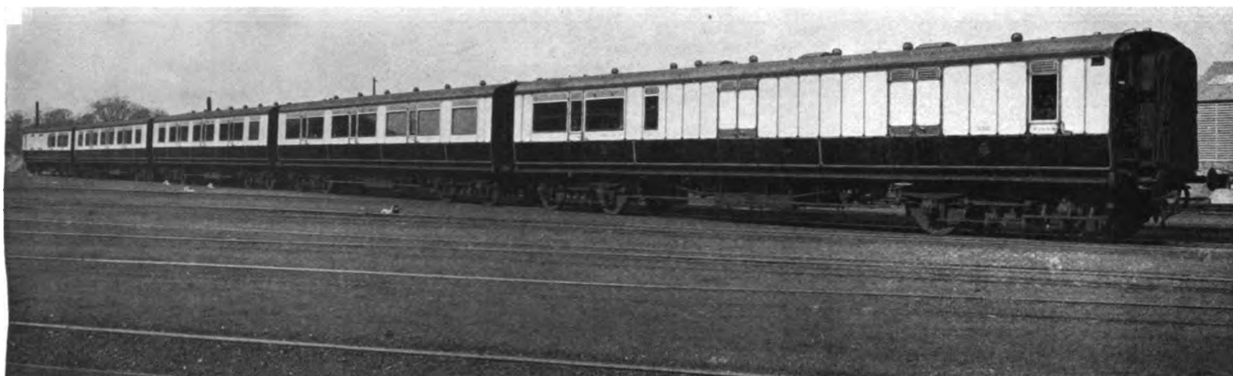

FIG. 31. VESTIBULED TRAIN FOR LONDON—MANCHESTER SERVICE, LONDON AND NORTH-WESTERN RAILWAY.

trains, and these cars have been built out to the same width as the rest of the train. The cars are all steam heated and lighted by electricity, and with their lofty interiors and large side windows are worthy representatives of the famous shops at Wolverton. The North Western's best train between Euston and Manchester is given exactly three hours and a half for the 188.75 miles, including a stop at Stockport. This works out at an average inclusive speed of 53.92 miles an hour. The only criticism which can be passed on these splendid trains is one common to most British stock and it is perhaps superfluous to repeat it, but one cannot help wishing that automatic couplers might be substituted for the old screw coupling and the side buffers abolished altogether, while the business of holding the train steady was entrusted to the vestibules.

Our next example is a train de luxe, first-class only, of the Northern Railway of France, and, as such, really belongs to our next chapter: but I introduce it here for the sake of the comparison in build with the train at which we have just been looking. The locomotive standing at the head of the train is one of the famous De Glehn four-cylinder compounds, the story of whose inception and perfecting I have already told elsewhere. Here I will only repeat that these engines marked a new era in French railway working and resulted in the creation of some remarkable speed records. The train, with which we are now more particularly concerned, represents as great an advance on French coaching stock of two decades ago as does the handsome Atlantic engine itself over the earlier locomotive stock. With the exception of the baggage van, it is vestibuled solid throughout. The cars are all built with side corridors on a composite underframing of steel and wood. The

bodies measure, approximately, 54 feet 2.87 inches long and almost exactly 9 feet 10 inches wide, over all. The wheels of each bogie are spaced 8 feet 2.44 inches apart and the cars weigh about 33 tons each.

This type of stock has been the standard on the Nord for main line express service since about 1900. The precursors of the new order of things appeared in the Paris exhibition of that year. One curious feature of the stock is that the end doors, which admit to the vestibuled platforms, are placed at an angle instead of following the almost universal custom of being parallel to the length of the car. The usual ladder is provided for giving access to the roof. This is quite a typical bit of continental practice and, though rather unsightly, seems to present some advantages for the users over the steps and roof rail of British stock. The 20-ton fourgon, or baggage car, is fitted with two large sliding doors on either side for loading baggage, as well as doors for the guard. Raised observatories are provided and, like the rest of the train, this car is lighted by electricity.

The train in our picture weighs not less than 280 tons behind the tender, which is a very good load for the high speeds at which the Nord's best trains are booked. The road's two most famous routes are from Calais and Boulogne to Amiens and Paris, the English boat trains, and the Nord express of the International Sleeping Car Company, which the Nord hauls as far as Jeumont, on the Belgian frontier.

On the former route the best train runs as follows:

Stations	Times P. M.	Miles from Calais	Miles bet. stops	Speed
Calais Maritime, dep..	1.15	.....	.....	
Amiens, ...arr..	3.08	103.75	103.75	55
" dep..	3.13			
Paris (Nord), ...arr..	4.45	185	81.25	52.98

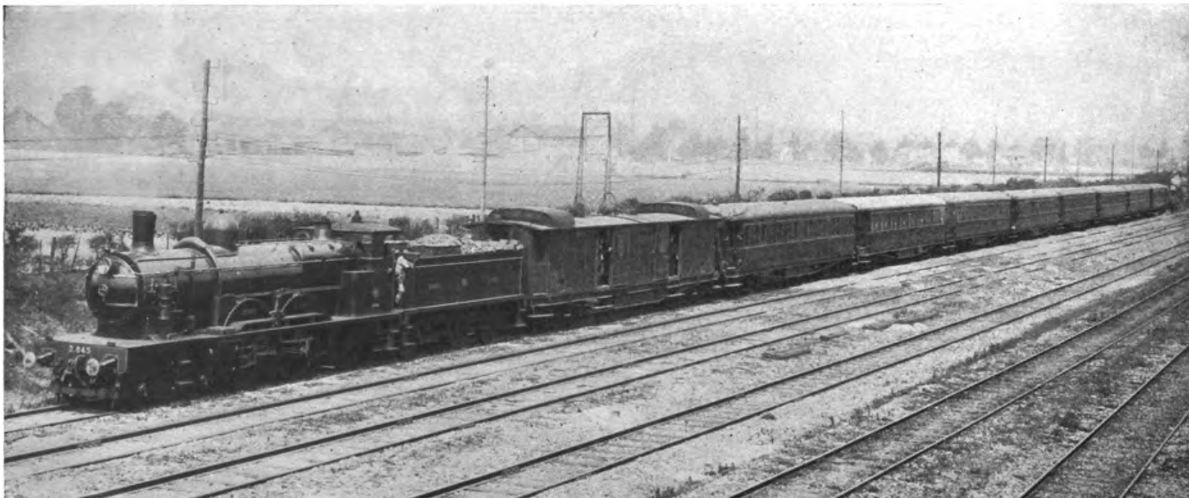

FIG. 32. WAITING FOR THE ENGLISH BOAT. A NORD FLIER NEAR CALAIS.

FIG. 33. UP THE ST. LAWRENCE. MONTREAL AND CHICAGO EXPRESS, CANADIAN PACIFIC RAILWAY.

This timing is really brilliant work over a road by no means easy, and, especially between Calais and Boulogne, abounding in sharp S curves. The Calais boat trains pass by Boulogne Central without stopping. The best train between Boulogne and Paris runs thus:

	P. M.
Boulogne Central, dep.	6.25
Paris (Nord), ... arr.	9.15

The distance is 157.75 miles, run with an intermediate booked stop. The speed works out at 55.67 miles an hour, again a very high average. And it must be remembered that this train takes third-class passengers from England and is therefore exceptionally heavy, judged by European standards.

For the timing of the Nord express, the following table gives us the principal outlines over the French rails.

Stations	Times P. M.	Miles from Paris	Miles bet. stops	Speed
Paris (Nord), dep.....	1.50	.....	.....	
St. Quentin, arr.....	3.25	95.75	95.75	60.47
" dep.....	3.28	.....	.....	
Jeumont,...... arr.....	4.25	147.75	52	54.73

According to the "Railway Magazine" the first stage of this journey is the second longest run in the world at a booked speed of over 60 miles an hour. The features of the locomotive work include a 12 mile bank of 1 in 200 against the down train and a weight of train behind the tender which has, on occasion, totalled up to 365 tons. It is performances like these which have gained Monsieur du Bousquet's smart engines their deserved reputation.

Our third example of a modern passenger train shall be the Montreal and Chicago express of the Canadian

Pacific Railway. This train runs over the Canadian Pacific metals from Montreal to Detroit, a distance of 569 miles. There it is handed over to the Wabash Railroad for the remaining 272 miles. The train consists of baggage car, and first- and second-class coaches as far as Detroit, while the company's own sleepers run through all the way, and a café car is attached between Toronto and Detroit. The weight is therefore a variable quantity. Probably if we reckon it at about 200 tons we shall not be far out. The train is of course vestibuled solid throughout and generally up to the high standard of the Canadian Pacific equipment. Our picture shows the train hauled by one of the new ten-wheeled express engines of the road.

These fine engines have coned boilers, giving 2445 square feet of heating surface and carrying a working pressure of 210 pounds per square inch. These locomotives are arranged as simple engines with cylinders 20 x 26, and the driving wheels are 5 feet 9 inches in diameter. The weight of the engine alone is 73 tons 7 hundredweight, the total weight of engine and tender being 127 tons 16 hundredweight. The particular engine illustrated, No. 869, was built, I believe, by the American Locomotive Company, but a good many of the same type and dimensions have also been built by the North British Locomotive Company at Glasgow.

The working of the train may bet set forth in outline as follows:

	P. M.	Miles from Montreal
Montreal, dep.	10.00	
	A. M.	
Toronto, arr.	7.25	338
" dep.	8.00	
	P. M.	
Detroit, arr.	3.10	569
Chicago, via Wabash R.R., arr....	9.30	841

It would be tedious and also a little unfair to set out all the intermediate speeds. There are thirty-four booked stops and four flag stops between Montreal and Detroit, which only allows an average distance of about sixteen miles between each. Under these circumstances the average speed of 37.37 miles for the whole distance, including all stops, must be considered to represent very smart locomotive work. The longest booked run on this train's schedule is between Vandreuil and Smith's Falls, 105 miles. In this distance there are three conditional stops and the time allowed is two hours thirty-eight minutes, giving an average speed of 39.87 miles an hour. The conditions and the results show some striking variations from the French time-tables just quoted, and the two trains may well be studied in conjunction as showing the wide range of service which has been developed in different countries by the circumstances of the respective roads. And it is, I think, the more interesting, when we remember that in all three examples which we have studied the general type of coach remains the same. In England, France and Canada, we find bogie vestibuled cars as the standard, in the two former cases, built with corridors, in the last named, built on the usual American plan of an open car. We cannot therefore be wrong in regarding the special type of passenger equipment represented as bearing with it something of finality in design.

IV

The Luxury of Modern Passenger Travel

In the present chapter I want to consider the various types of cars and carriages which have been produced to meet the ever-growing demand for comfort on the part of the railroad traveller of to-day. When once the idea became established that travel was no longer a disagreeable necessity, but a real pleasure, it became the aim of the railways in various parts of the world to minister to this new pleasure by every means in their power. As I have tried to show in the "Boys' Book of Locomotives" the railroads not only took over a travel business already existing, but they also to a larger extent created business which, but for the inducements they offered, would never have come into existence at all.

In this development of passenger travel many factors played their part. Cheaper fares, better cars, quicker trains, consideration in various ways for the comfort of the traveller, and attractive advertisements have all contributed to the final result. Just now we are mainly concerned with the second of the factors just enumerated. We have already seen that, in England, the first-class carriage to a large extent took the business and retained the shape of the old stagecoach. And thus it came about that the first-class was looked upon as the standard of travel, so to speak. It would seem, then, right to exclude the English first-class carriage and its equipment from our consideration in a chapter which is to be devoted to the study of special luxury. But English railways soon

found that there was a vast multitude of potential travellers who would always prefer to travel in the cheapest way possible. It is scarcely unfair to say that, beginning life with all the aristocratic prejudices of the feudal England that lay behind them, the companies discovered with dismay that their best friends were to be, not the millionaires, but the millions. It was reserved for the Midland to really enshrine this discovery in its timetables when it promulgated the simple rule "third-class by all trains."

Contrary to expectation, then, the English first-class is really entitled to be included in this chapter of what the French comprehensively term *voitures de luxe*. In America it was different. Things worked themselves out along other lines and the first-class really became the normal, corresponding to the English, and indeed to the general European, third. The ordinary English first-class compartment is, however, scarcely de luxe in any modern sense. Indeed an isolated and stuffy first, of the old style, is not to be compared for comfort to a modern corridor third. The great feature of this type of compartment was, and is, its arms and head-rests. These of course add considerably to the comfort of a journey, but not nearly so as to compare with the advantages of a corridor and lavatories. Another advantage, from the point of view of the insular Briton, is their loneliness. One first-class ticket per compartment seems to be quite a common experience save at holiday times. Whether it is an advantage from the point of view of railway dividends is another matter. Personally I feel strongly that the aimless hauling about the country of more or less empty coaches on the remote chance of an occasional first-class passenger turning up is an utter waste of money.

At the same time there are certain routes on which the first-class travel is an exceedingly profitable asset. There, of course, the companies make special efforts to deal with it, with the result that, in such cases, the British first-class becomes the equivalent to the American Pullman. One of these special instances is to be found in the services run by the various lines between London and the continent. There are four roads chiefly concerned in this business, all owning the cross-channel steamers as well as the trains. The London & South Western run via Southampton Docks to Havre. The London, Brighton & South Coast travel via Newhaven to Dieppe, and are interesting in our present connection because they do run Pullman cars on the day boat trains. Then the Great Eastern go to the Hook of Holland and Antwerp via Harwich, their only main line services in which second-class carriages now run; and, finally, the South Eastern & Chatham run several services via Queenborough, at the mouth of the Thames, Folkestone and Dover. These services take you to Flushing, Ostend, Calais, or Boulogne, in the first case by means of the Nederland steamships company's boats: in the second by the boats run by the Belgian State Railways and in the last two by either the English company's own steamers or those of the Northern Railway of France, which latter are working in some of the Dover and Calais services.

The boat expresses between London and the coast now have a number of coaches of the type illustrated in Figure 34, working in them. These are first- and second-class composites, the second-class being very comfortable, but quite ordinary compartments, each with a lavatory attached, while the centre of the coach is given up to one large first-class compartment, forming a kind of little drawing-room. In this compartment the end seats are

of the ordinary English type, but on either side of the room under the windows are arranged revolving arm-chairs. The whole forms a very comfortable vehicle for the short run between London and the coast ports, though of course the absence of corridors and vestibules would prevent its being a suitable type for long journeys. The coach is lighted by electricity and heated by steam in winter.

I have suggested that the carriage at which we have just been looking may be regarded as having its first-class portion arranged as a little parlour or drawing-room. The real home of the drawing-room car is, however, in America. There, the distances to be travelled are often so great that there is excellent opportunity for the car-builder to indulge in any fancies of design which may add to the comfort and enjoyment of passengers. Consequently many luxurious types of cars have been introduced available for ordinary passengers on payment of a supplementary fare. Most of this business is in the hands of the Pullman Company, but some of the roads manage and own their own parlour, dining and sleeping cars, notably the Canadian Pacific.

On most of the big roads there are now running limited trains, by which term is meant trains made up exclusively of these special types of cars upon which extra fares are charged. These limited trains are very luxurious and usually very dear. In this respect probably the third-class passenger in England is on the whole better off than the first-class passenger in the States, because practically every train in England, certainly all the best trains, carry third-class passengers. Out West, curiously enough, conditions tend to approximate to those of Great Britain. Thus our next illustration represents the interior of a car built for the Oriental Limited of the Great

Northern Railway. This train, in addition to the luxurious car of which our illustration gives a specimen, also includes both an ordinary first-class day coach and an immigrant or tourist sleeper.

The car shown in the picture is known as a compartment observation library car. This car has four staterooms and a drawing-room, so-called, which is simply a larger stateroom with separate toilet compartment. These sleeping compartments occupy about one-half the length of the car. They are all arranged with doors between so that two or more of them can be thrown into one if desired, and all open in addition into a wide corridor running down one side of the car. After this section comes a smoking-room, then a buffet at which light refreshments may be obtained, and lastly the large room in which our picture was taken which gives the car its distinctive feature and name. This room forms a parlour car, and is equipped with library and writing bureau, while at its rear end, in the direction in which the train is travelling, it opens, not into the usual vestibule, but on to a large balcony. This balcony or platform is surrounded by an ornamental railing and shaded by the car roof.

The changing panorama as the Limited climbs among the snow-clad Rockies or rushes along the great Wenatchee Valley makes a trip in this car in fine weather a thing to be remembered. We must remember that the need for running the observation car always at the rear of the train makes it necessary to reverse the train at each terminus. This is accomplished by means of a Y track, the train being drawn in along one arm of the Y and out again by the other. The Limiteds travel daily over the 1829 miles which lie between St. Paul and the ocean port of Seattle on Puget Sound. The booked time is exactly

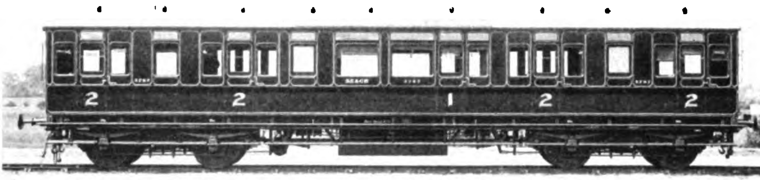

FIG. 34. COMPOSITE CARRIAGE WITH FIRST CLASS PARLOR: FOR THE CONTINENTAL MAIL TRAINS, SOUTH-EASTERN AND CHATHAM RAILWAY.

FIG. 35. FOLLOWING AN INDIAN TRAIL. OBSERVATION CAR ON THE ORIENTAL LIMITED GREAT NORTHERN RAILWAY (U.S.A.).

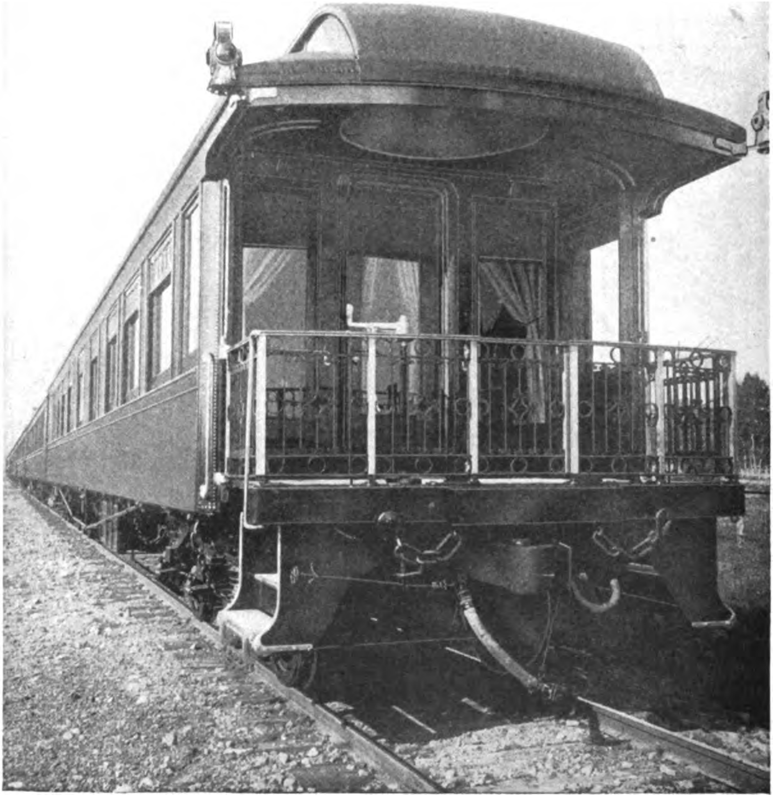

FIG. 36. CANADIAN PACIFIC OBSERVATION CAR.

58 hours, two nights and three days of travelling, and the average speed works out at a fraction over 32 miles an hour. Fifty years ago the only means of communication in the district were slow-moving trains of Red River wagons travelling in company for fear of Indian attacks.

Our next picture shows a view of the observation platform of a car such as I have described. This represents a splendid car, built by the Canadian Pacific originally for the special train which was allotted to the service of the Prince and Princess of Wales during their trip across Canada in 1902. This car was called the "Cornwall," in allusion to one of the titles of the British heir-apparent as Duke of Cornwall. It measures 78 feet 6½ inches long, including the observation platform, 10 feet 3 inches wide, while the clerestory reaches to a height of 14 feet above rail level. The special consisted of nine cars, one, a private car, "Sandringham," being furnished by the Government Railway of Canada, the other eight being all Canadian Pacific stock. The Canadian Pacific Railroad portion was marshalled as follows. Next to the engine came two baggage cars: then three standard sleepers, ultimately destined to run in the "Imperial Limited" service: these were named "South Africa," "India," and "Australia," respectively. After this followed the compartment car "Canada," a specially built sleeper, "York," and the "Cornwall." The train was of course most sumptuously fitted up, everything that could possibly minister to the wants of the travellers was provided, from a complete cold storage plant erected in one of the baggage cars, to a very thorough and elaborate telephone installation.

The "Cornwall" was of course a specially built car for specially favoured travellers, but the accommodation provided for ordinary folk is always tending more and

more to approximate to these high standards of luxury. Our next picture (Figures 37 and 38) gives us a glimpse of two cosey nooks provided on board some new Pullmans which have recently been put into service on the London, Brighton & South Coast Railway between its two principal termini.

A fuller description of the new "Southern Belle" and its service I am reserving for another chapter; meantime, however, we may just notice the air of homely comfort which pervades the rooms of the "Alberta" (Figure 37). The reader will see that the roof is of an entirely new design, in flat and almost unrelieved white, which is cunningly arranged to take away as far as possible from the sense of being on board a train. In this respect the car-builders are undoubtedly taking a leaf out of the naval architect's notebook, and endeavouring to impart to their swiftly moving buildings something of the character of a house. As in recent cars put into service in America, the revolving parlour chair has been replaced by a light but comfortable pattern standing upon four honest legs.

Another feature which deserves remark is the new arrangement of the electric lamps, which, instead of being grouped in brilliant electroliers, are now scattered about ceiling and cornices. The result is that the light is more diffused and less glaring, while at the same time the lamps over the chairs are much better disposed for reading. But probably the most important feature of the internal arrangements of the car concerns the building. The different members of the car body have been so disposed as to do away, as far as possible, with all cornices and outstanding pillars. At the same time all heavy ornamental moulding has been avoided, with the joint result of making the interior of the car far easier to keep clean than is the case with other methods of arrange-

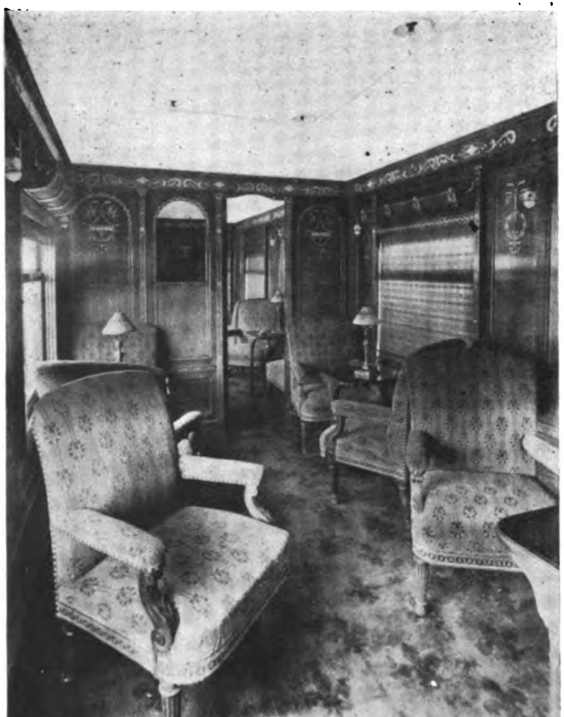

Fig. 37. Composite Parlor Car, "Alberta."

Fig. 38. Parlor Car "Princess Patricia."

From the City to the Sea in Sixty Minutes.

Two Cosy Corners on the London, Brighton and South Coast Railway Company's "Southern Belle."

ment. The great difficulty of dust on a railway journey is one of the things which ingenuity can do much to minimise, as these new cars prove, even if it should be impossible to get rid of it altogether.

Our companion picture gives us a view of the interior of another car for the same service; this car is called "Princess Patricia," and is, as will be noticed, of a more conventional railway type. It is built with a clerestory roof, of a very handsome pattern which the Pullman company have made very popular. In addition to the other ventilating arrangements note the electric fan under the break of the roof at the end of the room.

Our next example of the luxury of modern passenger travel comes from the lonely South African veldt. The photograph shows the exterior of a saloon built for the use of the Administrator travelling over the Rhodesia railways. This car was built by the United Electric Car Company, Ltd., of Preston, Lancashire, and though a private car is similar in general appearance to the rolling stock now in use on the South African trains de luxe, saving only that no vestibules are provided. Two limited trains are now run weekly between Cape Town and the North. One, for which the rolling stock is provided by the Central South African Railways, runs 628 miles from Cape Town to Norval's Pont; here the train is handed over to its owners who haul it over their own road another 386 miles to Johannesburg. The total distance of 1014 miles takes 48 hours and 58 minutes, an average speed of 20.69 miles per hour.

The other service runs due north to Kimberley, Mafeking, and Bulawayo. The train leaves Cape Town at 8.25 A. M. every Wednesday; reaches Kimberley, 647.25 miles out, at 3.55 P. M. on Thursday, and Bulawayo 7.20 A. M. on Saturday. The 1326 miles thus occupy 70 hours

55 minutes, and the average booked speed, including stops, is 19.20 miles per hour. A connecting train is timed to leave Bulawayo at 7.00 P. M. on Saturdays, and is due at Victoria Falls at 5.00 P. M. on Sunday, thus taking 22 hours for the 282 miles, a speed of 12.81 miles per hour. It is with this last section of this last route that the car illustrated in Figure 39 is connected.

I have given the particulars of these trains in fairly full detail because there is something very striking to the imagination in this bringing of the railroad into the dark places of the earth. Bulawayo itself, twenty years ago a blood-stained Kaffir kraal, now an important railway junction, is itself a town of romance, and in all the story of the railroad building of the last century, when it comes to be fully written, there will be no more romantic chapter than that which tells of the building and working of the Rhodesia Railways. The gauge of all these South African lines is standardised at 3 feet 6 inches. Some day, when connection has been made with the North, right through the very heart of Africa, these thousands of miles of line will all be converted to the world's standard gauge of 4 feet 8½ inches, millions of pounds will be wasted, capital utterly thrown away which might have been saved and applied to better uses, and all because the Cape railway administrators made a wrong decision in the matter at a time when it might easily have been put right.

Meantime, engineering skill is being applied to minimise, as far as possible, the inconveniences of such a narrow gauge. Engines weighing as much as 78 tons, exclusive of a 48-ton tender, are at work, and locomotives and rolling stock alike attain to a high standard of efficiency. The line is of course single track throughout except for sidings and crossing places. Stations are few

and far between; only the widely distant water tanks or sidings break the monotony of the tracks. The following extract from the Cape Government Railways official time book is eloquent of the conditions of railway working on these lines:

"TRAFFIC FOR SIDINGS WHERE THERE IS NO ONE ON DUTY.

"When traffic is consigned to a siding where there is no one on duty the Consignor must sign the indemnity note provided for the purpose relieving the Department of all liability respecting such traffic and prepay the freight. Traffic for sidings where there is no one on duty is left there at the sole risk of owner; such traffic must in all cases be fully addressed."

Lurking behind the dry official phraseology of this regulation you can trace the outlines of one of these lonely up-country sidings. A tropic vegetation is all around and the rails and the telegraph wire are the only link with outer civilisation. Twice a week the "Limited" crawls by, making her steady 13 miles an hour from depot to depot. Her locomotive whistle scares away antelope and giraffe, and the passing gleam of polished mahogany and shining brass links up for an instant that lonely spot with far-off London or New York.

These cars measure about 60 feet in length and no less than 9 feet in width over all, dimensions which are not exceeded by many British standard gauge vehicles, and one proof of the resourcefulness and daring of the engineers in trying to overcome the difficulties of the cramped gauge. Each of the trains de luxe consists normally of six cars, and weighs about 150 tons behind the tender. These cars comprise baggage car, compartment

sleepers, dining-car and observatory car. The name given to this last car, be it noticed, is the South African technical title, corresponding to the observation car of America. Our administration saloon is a very compact little house on wheels. It contains kitchen accommodation, bathroom, bedroom, dining-room, a cosily fitted office and a spacious platform at one end. The sides are closed with double windows and sliding sun blinds as our picture shows.

From the wilds we now come back to civilisation in the shape of a first-class car for the Belgian State Railways. This is first class of course in the English and European, not the American, sense of the word. This coach was built by the Baume-Marpent Company, of Haine St. Pierre, Belgium. The car will seat 42 passengers and its principal dimensions are as follows: Length, 59 feet 1 inch; width, 9 feet 8.54 inches; height, 11 feet 9.23 inches. The weight is almost 34½ tons (English). Practically the whole of the railway lines in Belgium are now the property of the State and, though the speeds are not high, yet the fares are cheap, and as our picture shows, the modern rolling stock being put on the road is very good. A curious feature about Belgian train services is that so many of the trains are second- and third-class only. This approximation to, and modification of, American practice strikes one as being a detail of train working which might be adopted with advantage in England.

The best trains on the Belgian State system are those connecting with the Dover boats at Ostend. One of these trains, the Nord express, runs non-stop between Ostend Quai and Brussels Nord. The 76.25 miles take 99 minutes, a speed of 46.21 miles an hour. This is not fast running as speeds go to-day and it is noteworthy that

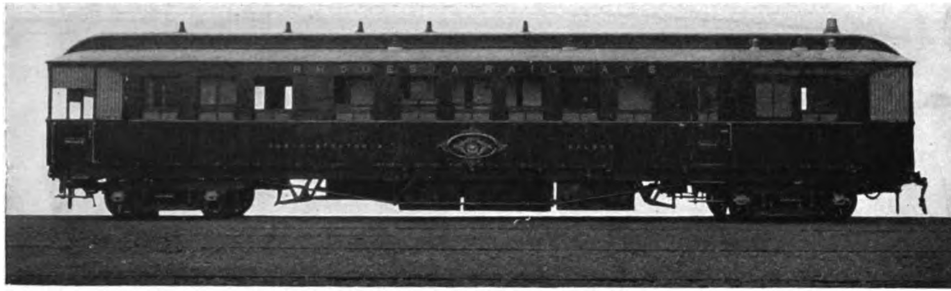

Fig. 39. Across the Limpopo. Private Car for the Rhodesia Railways.

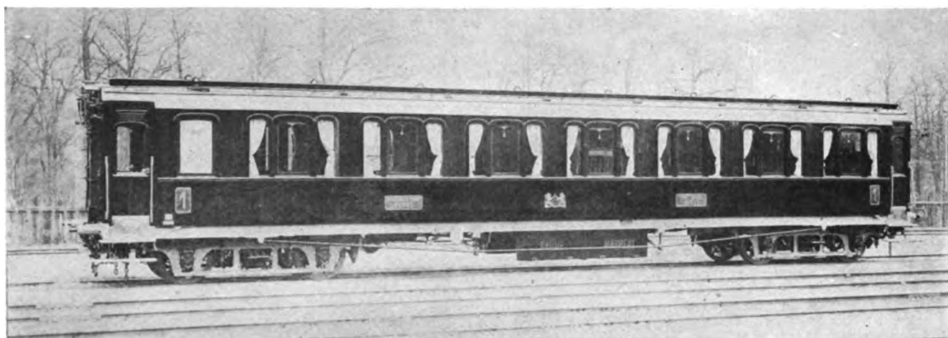

Fig. 40. First Class Car for the Belgian State Railways.

the boats, which belong to the Railway Administration, are relatively faster than the trains. For years the Belgian State mail steamers were the fastest boats on the English Channel, and the *Princesse Henriette* had at one time the reputation of being the fastest paddle-boat in the world.

We have now looked together at several cars from different parts of the world, intended chiefly, so far as they are distinctive in type, for day travel. But, in all the long journeys which have come before us, the most important object put before the car-builder is the provision of suitable accommodation for comfortable night travelling. One man's name will always be associated with the sleeping car, and travellers by rail in all countries owe a deep debt of gratitude to the penetration and resourcefulness of George M. Pullman. Sleeping-cars there were before ever Mr. Pullman's attention was called to the subject, but it was his careful attention to detail and readiness to dare to be singular which really brought about the improved sleepers of to-day. And it is an unconscious tribute to Pullman's work that his name has become almost a synonym for that class of vehicle, whether the particular coach to which the term may be applied be a product of the great Pullman drawing offices and shops or no.

General Horace Porter, who was at one time president of the Pullman Car Company, has left it on record that it was in 1858 that the inventor's attention was first called to the matter of endeavouring to improve the existing railway passenger accommodation. In that year he travelled one night from Buffalo to Chicago over the Lake Shore Railroad in a new sleeping-car which had recently been put into service. The discomforts of the journey made him begin to cast about for some means

of overcoming them. He soon began experimenting, and in the following year, 1859, he altered some day cars of the Chicago & Alton Railroad and converted them into sleepers. The present year thus marks the jubilee of the first Pullman car. These converted coaches were certainly an improvement over the old style of sleepers, but to Mr. Pullman they were only experiments, from which he kept seeking to work his way towards the ideal which was taking shape in his busy mind.

In 1864 he invested his savings in the construction of the first car built entirely from his own plans. This car was built in one of the Chicago & Alton's car sheds and cost its inventor the then large sum of $18,000. For the sake of comparison I may mention that previous sleepers had cost only about $4500, less than the cost of a modern British third-class car. Mr. Pullman named his car the "Pioneer." It had no number, but was designated by the letter "A." Not even the inventor's optimism went the length of supposing that there would be enough of his cars to exhaust the letters of the alphabet.

The "Pioneer" was built with a clerestory roof and carried upon two six-wheeled trucks fitted with equalisers. It was the first car to be fitted with hinged upper berths, the recesses behind which could be utilised for storing bedding during the day. To allow of this feature it was necessary to build the car quite two and a half feet higher than any coaches then running. It was also a foot wider in the body; indeed its diminsions were such that it was not possible for it to run over the line, but Mr. Pullman was confident in his car and persuaded that the correctness of its principles would bring it into service in spite of all obstacles.

In the spring of 1865 came the sad day when Lincoln's body was to be laid to rest at Springfield. Nothing

would do but that the "Pioneer" should be utilised, and so bridges and station platforms were altered to allow of its passing. Of course the alteration of overhead bridges was not so serious a matter in the West in those days as it would be now when they have so greatly multiplied, or as it would have been in England at any time. One route, the 185 miles between Chicago and Springfield, was now open for the "Pioneer," and others gradually followed. The width and height of this car became the standard for all future Pullmans though they have grown somewhat in length. In 1867 the Pullman Car Company was formed and arrangements made by it to run its cars through without change between widely distant points and over different connecting roads.

Our next pair of pictures gives us the interior of two typical Pullman sleepers. The first (Figure 41), shows us what the Pullman Company call their standard. It is a car of essentially the same type as the "Pioneer," having open berths, the occupants of which are only shielded from view by the curtains which are hung up when the beds are made. The general arrangements are the same as those of Mr. Pullman's first car, the chief differences being in the continually improving details of construction and equipment. It will be noticed that provision is made for lighting the car either by gas or electric light as in the case of the other cars of the company. This enables them to work over railroads using either illuminant. The exterior of the car is shown in Figure 43. The separate windows, seen at one end of the vehicle in this view, belongs to what is technically termed the "drawing-room." This is really a separate stateroom, affording extra privacy, and for which an additional fare is charged, over and above the usual Pullman sleeping-car ticket.

For it must be owned that, comfortable as the "Abilene" is as compared with the alternative of sitting up all through a long night journey, yet there are disadvantages still remaining to be overcome. For one thing, privacy in a standard sleeper is something so entirely impossible that undressing is really out of the question. The only disrobing that can be done must be essayed within the confined limits of one's own berth, and this tends to be somewhat of a gymnastic feat, especially for the occupiers of the upper berths. However restful the night may be to those hardened travellers who can sleep on a train, the going to bed and the getting up again is distinctly exciting.

An improvement on the old standard type was thus only to be looked for. Our next picture (Figure 42) shows the form that this improvement has taken. Here we have a view taken in a Pullman compartment sleeper. In this type of car the berths are all shut off in separate staterooms, each cabin having one upper and one lower berth and usually a sofa. The berths, like those in all Pullmans, are double if two friends like to squeeze into one, so that each cabin can, at a pinch, sleep five persons, three being of course the more usual number. Down one side of the car, the right-hand side in our picture as you look at it, runs a corridor, and, as our picture shows, doorways are also provided between one compartment and the next so that, if desired, two or more cabins can be thrown into one. When the staterooms are to be used separately these doorways are closed by sliding doors, locked of course by the porter in charge of the car.

These splendid vehicles represent the height of luxury for night travel. They accommodate, however, considerably fewer passengers than the standard

FIG. 41. STANDARD SLEEPER.

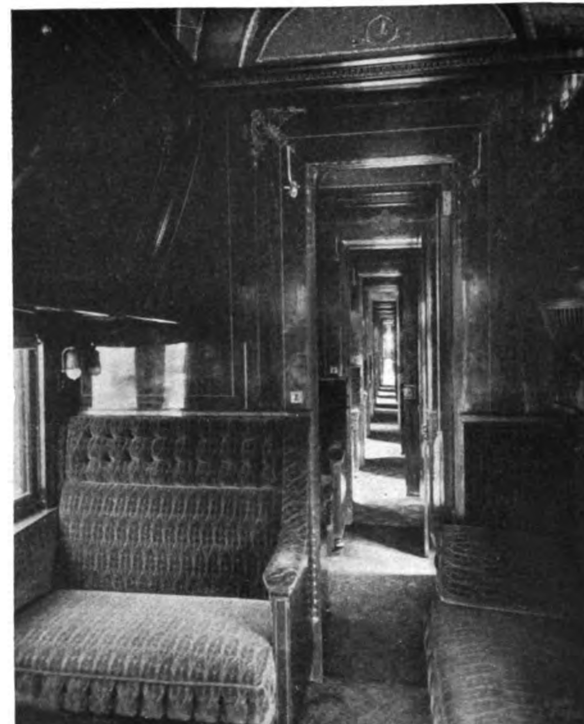

FIG. 42. COMPARTMENT SLEEPER.

TWO PULLMAN SLEEPING CAR INTERIORS.

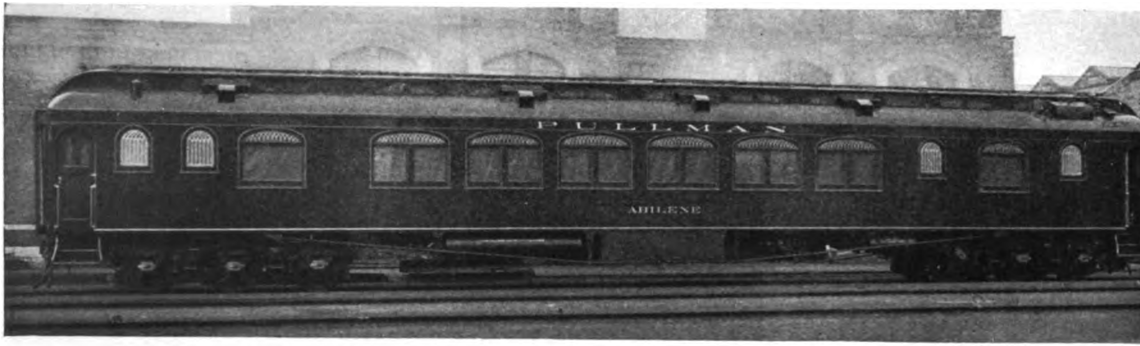

Fig. 43.

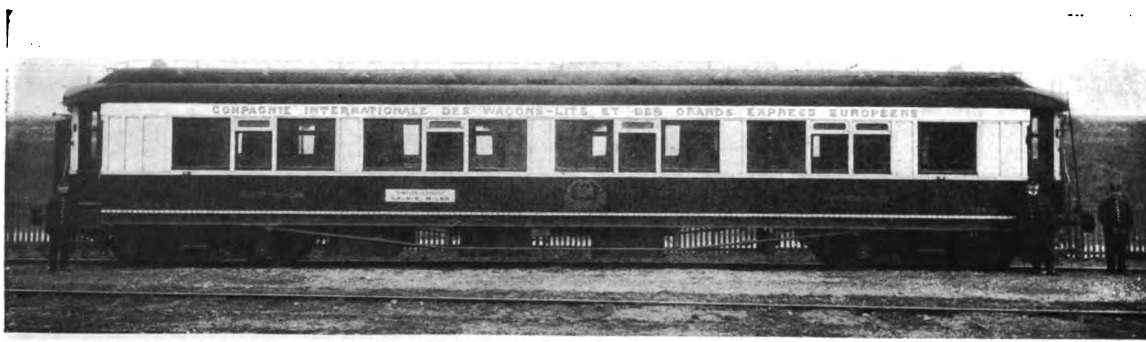

Fig. 44.

Sleeping Cars of two Continents.

Fig. 43. America. Fig. 44. Europe.

type, consequently the fares charged by them are much higher and also there are comparatively few of them running.

What the Pullman Company has done in America, the International Sleeping Car Company has sought to do in Europe. Their task has been in many ways a harder one than that before the American corporation. International political jealousies have often manifested themselves in very vexatious ways in railway matters, and the Sleeping Car Company has not seldom found that statesmen put far more difficulties in the way of the world's progress than engineers can remove. The earliest sleeping car did not appear on the continent of Europe until 1875, sixteen years later than Mr. Pullman's first attempts in the United States. Two years previous to this, however, sleeping cars were introduced on the West Coast route between London and Scotland. The first European service was between Berlin and Aix-la-Chapelle. The company's early cars were small four- and six-wheeled coaches about 36 feet long. In Figure 44 we have the picture of one of the company's modern cars, measuring about 60 feet long and weighing about 35 tons. The largest cars they have are some new sleepers which began running towards the end of 1908 in the "Sud Express" services between Paris and the Spanish frontier. These are twelve-wheeled cars, 70 feet long and with a weight of no less than 50 tons.

Like the Pullman Company, the Sleeping Car Company do not confine themselves to running single cars from point to point. As is implied in the second half of their long title painted along the top panel of the car in the picture, they also run a number of limited expresses over the lines of various companies in Europe. The first of these trains to begin running was the "Orient Ex-

press," which inaugurated in 1883 a new direct service between Paris and Vienna. This train has since been extended to Constantinople on three days in the week, and to the Black Sea port of Kustendje via Bucharest twice a week.

The car in our picture is one running in the Simplon Express, which now runs through three times weekly between Calais and Milan via the famous Simplon Tunnel. These modern sleepers are exceedingly comfortable. They are all arranged on the compartment plan and in the latest stock a toilet compartment is fitted between each pair of staterooms. A plentiful supply of water is laid on, a great matter on a long journey, and during the winter months hot water as well as cold is provided. The chief fault perhaps to be found with the Sleeping Car Company is their high tariff, which is considerably dearer than the American. On the other hand the traveller really does get a good deal for his money both in luxury and speed.

The external appearance of these cars is very handsome. The lower panels consist of close-tongued and grooved teak strips, finished only in the natural colour of the wood, while the upper panels are brilliantly polished and finished in a kind of ivory white.

The company's operations are not confined to Europe. Their Trans-Siberian Express runs right across Asia to Vladivostock and they also have a good many sleeping- and dining-car services in Northern Africa and Egypt. Our next picture shows us the daily train de luxe between Cairo and Luxor. This train leaves Cairo at 6.30 P. M., arriving at Luxor, the site of the ancient and mysterious Thebes, at 8.00 A. M. The cars composing the train differ from the Sleeping Car Company's European standard type so far as outward build and fin-

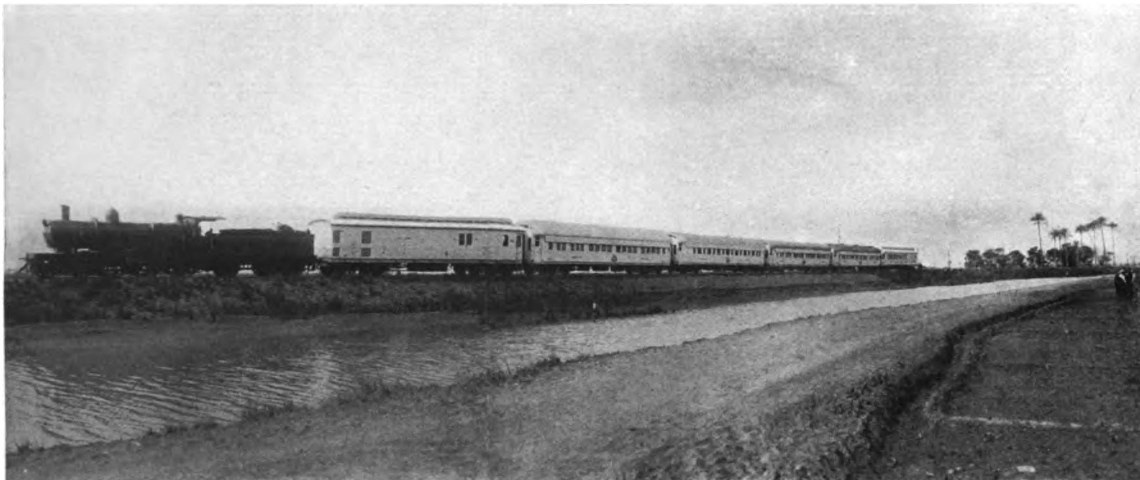

Fig. 45. Under an Eastern Sun: Cairo—Luxor Express, Egyptian State Railways.

ish is concerned. In view of the power of the Egyptian sun they are finished all in white and the sleeping-cars are all provided with double roofs and external lowered sun blinds. Our picture shows the train with one of the fine four-cylinder compound Atlantics of the Egyptian State Railways at its head.

Figure 46 brings us back again from Africa to Europe. It represents a train of cars built by the Hungarian Railway Carriage and Machine Works for the Hungarian State Railways. The photograph was taken in the builders' sidings at Raab. Raab, the Hungarian Guyor, is the old Roman Arabona, and is built on a marshy flat of the river Raab near its confluence with the Danube. It is 75 miles southeast from Vienna and about the same distance west of Buda Pesth. The Hungarian State Railways centre on the capital, whence five main lines may be distinguished. The busiest one is the 180-mile stretch between Buda and Vienna in a general northwesterly direction, via either Raab or Pressburg. Then, southeasterly, two lines run which meet again later on at Bucharest. One of these routes, via Szegedin, Temesvar, and Verciorova covers 544.75 miles between Buda and Bucharest and is one of the alternative routes of the Orient Express which I have already mentioned. This line leads on to Rustchuck and Varna, Bulgaria's Black Sea port, though the famous train runs to Kustendje, the Roumanian port, nearly 100 miles further north.

Another Hungarian State line runs nearly due south to Belgrade, 217.75 miles; this is on the main Orient Express route to Constantinople, the great highway between West and East. The fifth main line goes off to the southwest, past the shallow waters of the Platten See, to Fiume and Trieste at the head of the Adriatic.

All these busy routes are served by trains which, if not very fast, are certainly very cheap. Fares are based on a system of zone tariff which provides some of the cheapest travelling in the world.

There are three zones for level local traffic as follows:

Zone	Length Kilometre	English Miles	Fares—Pence 1st.	2nd.	3rd.
1.	1–10	⅝– 6¼	6d	3d	2d
2.	11–15	6⅞– 9¼	8	4½	3
3.	16–20	10–12½	10	6	4

Beyond these local zones there is a double tariff, one for slow trains, "personenzugĕ," and another, about 20 to 25 per cent. higher, for fast trains, "schnellzuge"; while for expresses, which are mostly first-class only, an extra supplementary fare is charged. As a specimen, for comparison with English and American passenger fares, I add the rates for a journey of 100 miles: these rates come into force at the 100 miles and carry you up to 108½ mles.

	Slow		Fast	
1st Class..............................	11/-	$2.75	13/9	$3.30
2nd "	7/4	$1.75	9/2	$2.20
3rd "	4/7	$1.10	5/6	$1.30

My readers will gather from this table that Hungarian second-class is roughly equal to English third-class or American first-class, so-called. Now if they will turn to our picture they will see the kind of modern coaching stock which is provided for this class of passenger. These second-class cars are bogie corridor compartment cars, equipped with end doors and vestibules, and with

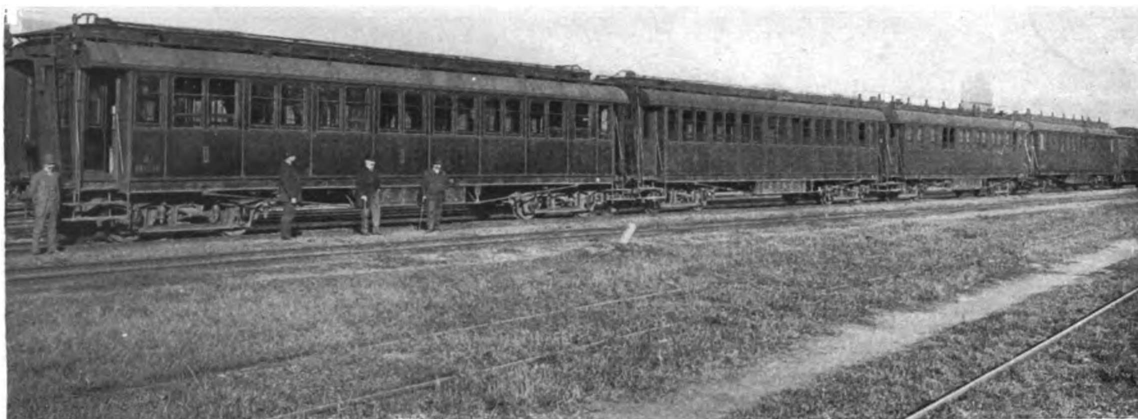

FIG. 46. VESTIBULED TRAIN FOR THE HUNGARIAN STATE RAILWAY.

clerestory roofs. The little 4-wheeled brake van somewhat detracts from the appearance of the train, which is otherwise a very good example of present-day continental practice.

In Figure 47 we have a sleeping-car interior on the Hungarian State. This, with its companion English picture (Figure 48), represents an arrangement of compartment sleepers differing from the usual Pullman type. In the Hungarian car we have a two-berth compartment without upper berths, the result being a very pleasant airy room. Notice that in both the Hungarian and English examples the passenger lies down across the car, and not in a bunk parallel with the car length as in the Pullman.

Figure 48 represents a single-berth compartment in one of the new cars for the West Coast Anglo-Scottish service of the London, North Western and Caledonian railways. For downright comfort this splendid specimen of North Western handiwork is hard to beat. As the illustration shows, the car is fitted with single-berth staterooms, which, as in the case of the Pullman compartment sleepers already considered, can be combined into suites of two or more cabins by means of sliding doors. In addition there are usually two rooms on every car containing two beds apiece. These double-berth cabins are arranged with the beds on the same level, the upper berth system being now entirely eschewed. Each cabin has its own shut up toilet commode similar in design to modern maritime equipment. Every precaution is taken to make the sleepers as noiseless as possible when running. Double floors deaden the sound, carefully arranged springs and well-balanced wheels minimise vibration, and last, but not least, almost faultless tracks and long non-stop runs make the running smooth and restful. On

the Highland Sleeping Car Express the London & North Western carefully tuck you up and shut you in at Euston, and, unless you wake and ring for refreshments meanwhile, will not allow anyone to disturb you all the way to the Scottish border.

Figure 49 shows the exterior of one of these cars. From this it will be seen that they are of the twelve-wheeled type and fitted with vestibules. All the vehicles for the West Coast service are now being standardised to a length of 65 feet 6 inches and a width of 9 feet. This is a movement which I am specially glad to record. It means cheaper and readier construction, because the underframes, bogies and running gear of all coaches are identical and it must also make for increased steadiness in running. The introduction into a train of even one vehicle of different dimensions to the rest must tend to set up in running a series of discordant vibrations which communicate their disagreeable influence throughout the train.

On the same page Figure 50 shows us a picture of a car belonging to the West Coast's deadly rival, the East Coast. Apart from differences in detail, the general design of the two cars is strikingly similar, and neither has anything to fear from comparison with the other. Both cars run on a pair of six-wheeled bogies, both have clerestory roofs, both are vestibuled, both have a similar plan of stateroom arrangement. But the outward appearance is very different. The West Coast car—why will they stick to the use of that ugly word "Saloon"?—has waist and upper panels of a beautiful, shining white, while the lower panels, corner pillars, etc., are finished in a very deep chocolate. The East Coast car is finished in very handsome varnished teak, relieved with gold lines.

As the titles imply, these two routes are the shortest

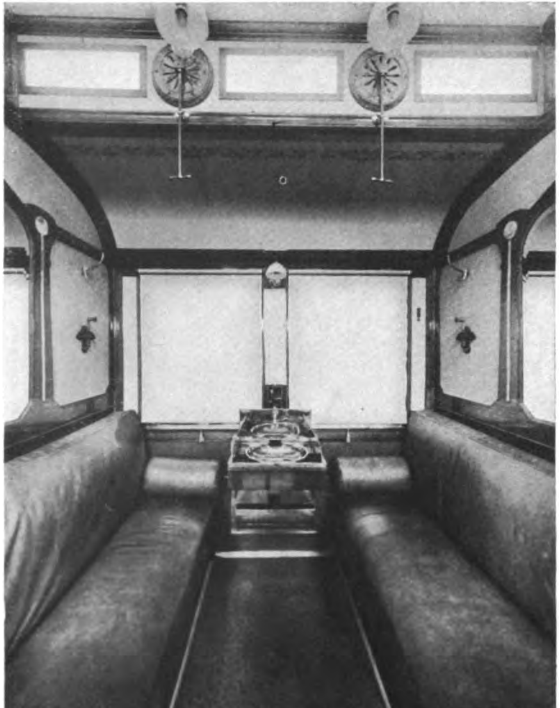

FIG. 47. TWO-BERTH SLEEPING COMPARTMENT.
HUNGARIAN STATE RAILWAY.

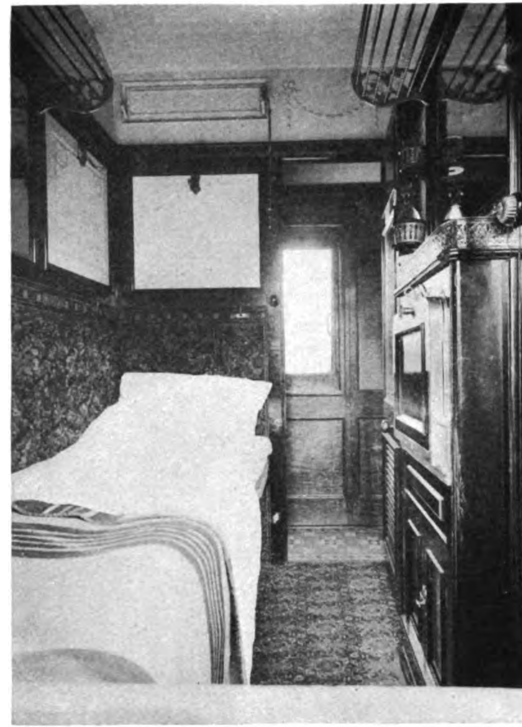

FIG. 48. SINGLE-BERTH COMPARTMENT.
WEST COAST JOINT STOCK.

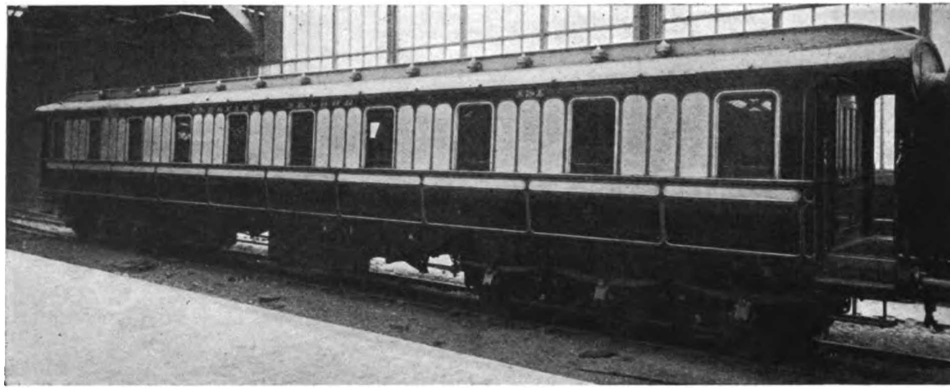

Fig. 49. West Coast Sleeper.

Fig. 50. East Coast Sleeper.

The Rivals.

and best to those parts of Scotland situated in the east or west respectively; but as a matter of fact, through the ramifications of their Scottish connections, they fight one another very cheerfully over practically the whole territory, while the Midland also seeks to have a hand in the fray. It seems almost impossible, by the way, to avoid these military methods when speaking of the Scottish border, but, as a matter of fact, a treaty of peace is more or less in evidence just now. One advantage of this is a complete interchangeability of tickets so that tourists can go one way and come back another. A curious feature of Scottish railway politics is afforded by the practical monoply of traffic between Perth and Inverness and the North, which is enjoyed by the Highland Railway. At Perth all rivalry must be laid aside and East Coast, West Coast, and Midland sleepers and corridor cars are all meekly marshalled by the omnipotent Highland into one long procession. In the summer time these processions are representative of railway practice all over Great Britain. Carriages, private saloons, horse boxes and carriage trucks are assembled from nearly every line in the island, and with Highland engines attached fore and aft the caravan, to quote Professor Foxwell, "toils over the Grampians," along mostly single line, dropping vehicles of one sort or another at all sorts of little lonely way stations, until the remnant, now with only one ten-wheeler hauling it, goes roaring down the long bank between Dava and Forres and so into the northern capital, Inverness.

After the invention of the Pullman sleeper, dining-cars were the next demand of the travelling public. A steamboat, said the American traveller, does not tie up at a wharf for meals, why should a railway train stop at a station? In 1867 the Pullman Company made a move

in this direction by devising a car which they called the hotel car. This was a sleeper with a kitchen and pantry at one end. Portable tables were provided to be fitted between the seats of each section, when the car was in daylight trim with beds and bedding out of the way, and upon which meals could be comfortably served. Some arrangement of this kind is now in fairly general use, though on a much smaller scale, nearly all sleeping-cars being equipped with a buffet, or at least with some provision for serving light refreshments during the journey. This first hotel car was supplied to the Great Western Railway of Canada, now part of the Grand Trunk.

In the following year, 1868, the first real dining-car was put into service on the Chicago & Alton Railroad. This car, the prototype of all subsequent dining-cars, was arranged exclusively for day travel. This enabled the interior to be made more roomy and airy than when meals had to be served among the curtains and cushions of a sleeper. The earliest dining-car in England was introduced by the Great Northern Railway in 1879. It ran between London (King's Cross) and Leeds and was first-class only. The pioneer third-class diners started to run in the Midland-Scottish services in 1893, and since that date the use, popularity, and profitableness of the dining-car has increased by leaps and bounds. Figure 51 shows us the interior of a Midland third-class diner. The seats accommodate two persons on one side of the aisle and one on the other. This car is lighted by Pintsch gas and heated in cold weather by steam. The Midland also were the first to inaugurate cross-country dining-car services, a convenience which business men quickly appreciated. Like all the Midland equipment, these cars are absolutely first class in everything but name. Only one criticism can be passed upon them, though that is

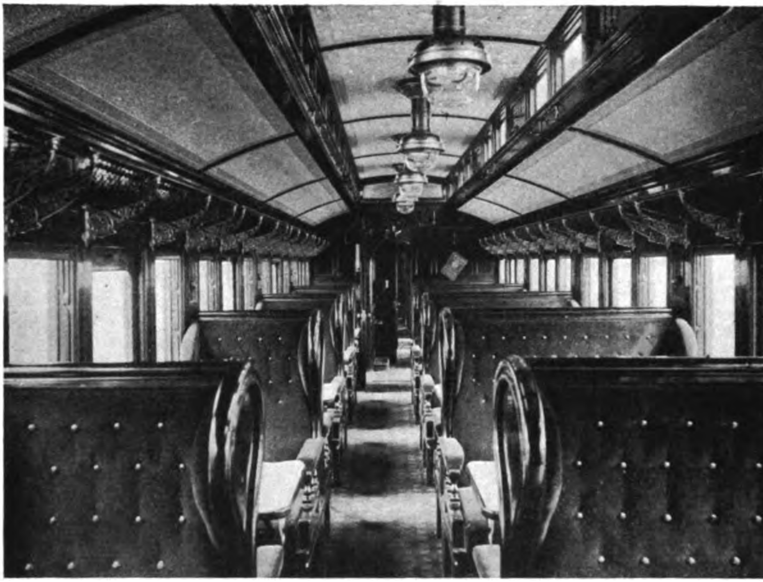

FIG. 51. THIRD CLASS DINING CAR, MIDLAND RAILWAY.

FIG. 52. IN THE PANTRY OF A LONDON AND NORTH-WESTERN "AMERICAN SPECIAL."

rather a serious one, that so many of their trains, even when dining-cars are attached, are not vestibuled. Consequently to make use of the comforts provided, a passenger must either travel in the dining-car the whole way or else submit to the discomfort of changing at some stopping station. In the former case the railway is losing money, for it can only sell one meal on the journey instead of two or three, and in the latter case there is the trouble and discomfort to the passenger involved. He, or she, has to find whether there is room in the dining-car, then to get a porter to help shift all the travelling impedimenta, and finally to get stowed away as best may be in the fresh vehicle.

I am glad, however, to add that the company is recognising the defects of this arrangement, and the vestibule is beginning to make its way on the Midland. We may remind ourselves, by the way, that it was the dining-car which was the final factor in bringing about the vestibule in America; its advent made some safe means of passing from car to car an imperative necessity.

Figure 52 takes us behind the scenes of the dining-car to the kitchen and pantry. There is not any room to spare on a train and the planning and equipment of the working department of the car taxes the designer's skill to the uttermost. Our picture shows us the pantry with a glimpse of the kitchen beyond. When one considers the excellent fare and dainty service provided on the dining-cars of to-day, one is amazed at the organisation, system, and skill which has gone to the building up of such fine records under circumstances of so much difficulty. The cooking is done by means of a gas cooking-range and water is carried in tin-lined copper cylinders, cased in light oak and suspended from the roof.

This picture represents a new car for the "American

Special" of the London & North Western. These splendidly equipped trains now run as required between London and Liverpool to connect with outgoing or incoming Atlantic liners. The Riverside Station, Liverpool, is right alongside the Great Prince's Landing Stage. Passengers can walk between steamer and train under cover, and when an Atlantic "greyhound" comes in, the first special can be away 30 minutes after the ship is made fast. From the Riverside two little six-wheels-coupled saddle tank locomotives draw the train up to Edge Hill. The long vestibule cars go hurrying over swing bridges and twisting and turning among stacks of goods piled high in the dock warehouses and then toil up through the long tunnel to where the smart "Precursor" type main line engine is waiting for them in Edge Hill Station. From there the 193.5 miles to Euston are reeled off, non-stop, in three hours and a half.

The next pair of pictures show us two dining-saloons for these American boat trains. One is first class and the other is third, though it is hard to tell the difference between them. They both have the new elliptical roof which is to a large extent replacing the clerestory pattern on the east of the Atlantic. It is noteworthy, too, that in both classes light, comfortable armchairs have replaced the old solid railway seat arrangement. This is an innovation which we owe to the Pullman Company.

Our next picture shows us a new train put into service in 1906 by the Great Eastern Railway to work between York and Harwich, at which latter point connection is made with the company's fleet of steamers running to the Hook of Holland and Antwerp and also with the General Steam Navigation Company's boats for Hamburg and the Forenede Line's vessels for Esbjerg and Copenhagen.

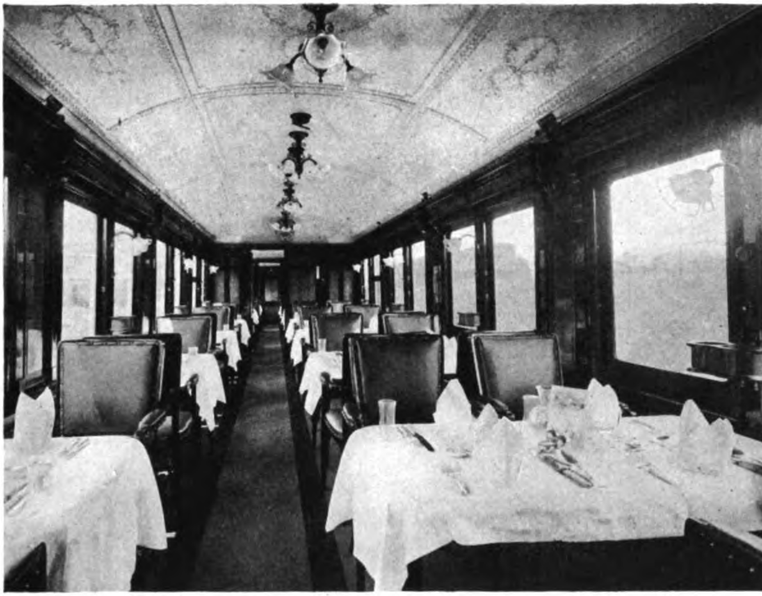

FIG. 53.

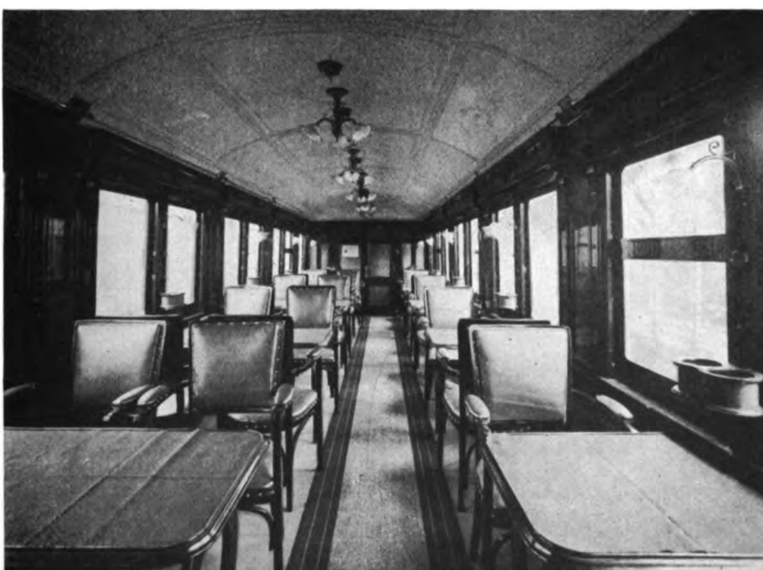

FIG. 54.

WHICH IS WHICH? FIRST AND THIRD CLASS DINERS, LONDON AND NORTH-WESTERN RAILWAY.

The train leaves York at 4 P. M. and arrives at Parkeston Quay (Harwich) at 9.30. Cars from the Lancashire and Yorkshire line are picked up at Doncaster, from the Great Central at Lincoln, and from the London & North Western at March. The train consists of uniform eight-wheeled bogie carriages, except for one six-wheeled brake van. It is built to the extreme limits of the loading gauge as regards height and width and is of course vestibuled throughout. Alongside the turbine steamer at Parkeston Quay it meets a similar train which has come down from London. These trains total up to 320 tons behind the tender, so that, although the booked speed is not high, the locomotive performance is very creditable. On the other hand the grades between Harwich and York are easy, the chief obstacles being rather the many stops and junction slacks.

I may perhaps call attention just here to one notable difference between railroad practice in America and Great Britain. In America it is the invariable rule on all long-distance trains to attach dining-cars at meal hours and drop them again as soon as convenient when meal time is over. In England, on the other hand, a dining-car is run all the way if at all. No doubt there are difficulties in the way of the adoption of the American plan in Great Britain. For instance, it might easily happen that the first-class diner should get marshalled next to the train, if the cars were attached at a way station. In this case passengers wishing to reach the third-class diner would have to pass through the first-class car to reach their places. But, as a matter of fact, this happens daily even now and is only one more proof that the very illogical and chaotic English class system is breaking down under the stress of modern conditions.

If British railways adopted the American plan they

would save a great deal in avoiding the haulage of very heavy cars over long sections of road where they earn no money. By some care in arranging train times to suit, it might often be possible to attach the dining-cars so that they travelled with a train while it was passing over an easy section of the road. By this means additional cars might be provided on a given train. If we take, for example, the very handsome and comfortable twelve-wheeled diners of the Great Northern, the weight of a pair of them, first- and third-class, in running order cannot be much under 80 tons. This is a weight, the cost of hauling which at the high speeds of to-day, would make the trouble of such re-arrangement as I have ventured to suggest amply worth while.

Our next picture, the last example of modern luxury in passenger travel, is an instance of the practice to which I have just been alluding. The "Pennsylvania Special" appears in our picture as composed of four cars only. On certain sections of its journey, however, the train consists of five cars. A dining-car is attached from New York (Jersey City) and is dropped during the evening at Altoona, while another one is picked up some time in the small hours of the morning at Alliance and is thus ready to serve breakfast during the 385-mile journey into Chicago. It seems a pity this last car could not be found at Fort Wayne, which would save another 237 miles. The movements of the car depend, however, also on the east-bound train, which in this case reaches Fort Wayne at 5.25 P. M., which would be, of course, too early to drop the car. This example of the Pennsylvania working thus shows very well both the advantages of the plan and the difficulties which have to be faced when it comes to be actually applied. I append the log of this important train in some detail.

FIG. 55. VESTIBULED DINING CAR BOAT EXPRESS RUNNING BETWEEN YORK AND HARWICH, GREAT EASTERN RAILWAY.

THE PENNSYLVANIA SPECIAL

		Miles from Last Stop	Miles from Jersey City	Speed Between Stops
	p. m.			
Jersey City..........dep.	4.05	....	....	....
Philadelphia.......... " (North)	5.37	85.	85.	55.43
Harrisburg...........arr.	7.30	105.3	190.3	56.79
" ....dep.	7.34			
Altoona.................	....	116.9	307.2	....
Pittsburgh...........arr.	12.40	131.4	238.6	48.68
" ....dep.	11.45			
Alliance.................	....	83.	521.6	
	a. m.			
Fort Wayne..........arr.	5.54	237.	758.6	52.03
" ....dep.	5.56			
Englewood...........arr.	8.32	141.	899.6	53.23
Chicago.............arr.	8.55	7.	906.6	....

The exact time of this train "over all," including, that is, the ferry between New York and Jersey City, is just 18 hours, which gives an average speed of almost exactly 50 miles an hour, a record for so long a distance of which the Pennsylvania is justly proud. My readers will notice that the time is changed one hour at Pittsburgh, so that the train appears to leave there 55 minutes before it has arrived.

The capital invested in the train amounts to no less than $150,000 (£30,000) for the Pullman cars alone. The first car on the train in our picture is a composite car. It has limited accommodation for stowing baggage, a barber shop, a bathroom, a buffet which is open whenever there is no diner on the train, and a parlour for smokers. The next two cars are compartment sleepers, of the type we have already studied, and the last one is an observation car with staterooms. The engine hauling the train in our picture is one of the Pennsylvania Lines'

large new Atlantics. Contrary to present practice on the Pennsylvania's great rival, the New York Central, these locomotives are simples. They are built with fire-boxes of a rather peculiar shape, a combination of the semi-wide and Belpaire types.*

The crew of this train consists of twenty men. At the head comes the Pullman conductor. He is solely concerned with the passengers and has nothing to do with the running of the train. His business is to see that passengers have the excess Pullman tickets required for the train, that the train porters do their duty and that the comfort of travellers under his care is properly provided for. The composite car has three men, a baggage-master, a barber, who is also bathroom attendant, and a porter, who also takes care of the buffet. Each sleeper has its own porter in charge, and the dining-car has its own crew of eight men, consisting of conductor, cooks, and waiters. Then there is the railroad company's train conductor and a couple of brakemen under him; these three change at the end of each section with the locomotive crew. So we have:

Pullman staff	7	men.
Railroad staff	3	"
Railroad diningcar staff	8	"
Railroad locomotive staff	2	"
	20	"

This train suggests another comparison of British and American methods in the way of dealing with baggage. It certainly does seem as if it would be wise to adopt in Great Britain the American plan of limiting the amount allowed on fast expresses. There is no more prolific

* See the Boys' Book of Locomotives, Chapter II.

Fig. 56. New York—Chicago, 18-hour Special, Pennsylvania Railroad.

source of loss of time, especially during the movement of the heavy summer traffic, than the piles of luggage which have to be dealt with. By the practically universal adoption of the luggage in advance system, English roads have made a start in the business of educating their patrons up to the idea of learning to part with their personal belongings. But the conservative Briton, it is to be feared, still persists in spoiling a line's time-keeping, and his own temper, by insisting on seeing each several article duly stowed away in the van on the train by which he is travelling. Some day the long-suffering English railway will put its foot down and insist on passengers by 50-mile-an-hour trains taking with them only hand luggage and handing over their heavy baggage to be dealt with separately.

We have now passed in cursory review the practice of railroads and car-builders in various parts of the world as directed to the provision of what the New York Central calls "the luxury of modern passenger travel." We have seen enough, I hope, to make us appreciate our privileges in living in these days when all the resources of applied science are being constantly put into operation to carry the lucky passenger more quickly, safely, and comfortably over journeys which may now extend to regions where, only a few years ago, were nothing but trackless jungle and perilous wilds.

V

Suburban Traffic

In our present chapter we have to come back from our imaginary journeyings in the luxury of a vestibuled express to the humdrum wear and tear of a suburban service. Under this general heading there are a great many varieties of traffic, ranging from the overhead or tube railways of our great cities to the point where it is hard indeed to tell whether to class a train among our lowly suburban or the lordly main line services.

The problem of local inter-communication in big cities is a serious one. It cannot be completely solved by the railroad engineer alone; it demands also the help of the street railroad or tramway to assist in the movement of passengers requiring to go only very short distances. The railway, strictly so called, only comes in where the passenger requires to go so far that it is worth his while to go out of his way to the station or depot, climb up or downstairs, take his ticket and wait for a train. It seems a great pity, especially with the facilities afforded by electric power available, that a service of single-deck street cars cannot be arranged to connect directly with a railway. By this I do not merely mean that the trams should run near to the railway station, but that there should be actual physical track connection, so that a street car which has, comparatively speaking, crawled along in the thick of city street traffic, may at any suitable point run on to a railway, and either singly, or preferably made up into a train with two or three other cars coming

along different street routes, run off as a comparatively fast connection to distant points.

I am sure that this can be done. Unfortunately no one can be sure that it will be done. In other words the difficulties attending the scheme lie not so much with the engineers as in the fact that between the railways proper and the surface roads there is usually a great deal of jealousy and hostility. The competition between the two methods of transport does not lie so much in methods of ownership, whether this is municipal or private, as in the very nature of things, and, from the point of view of the traveller who merely wants to get about quickly, easily, and cheaply, some sort of combined scheme such as I have suggested seems to offer far greater facilities than could be afforded so long as the two ways of transport are merely competing with one another.

An instance of the kind I mean is to hand in London. The London County Council cars run through the streets from Islington nearly to the great east and west thoroughfare of Holborn, then plunge into a shallow subway where they work almost as trains, stopping only at stations, until they emerge on the Thames embankment where they again become street cars. This is the kind of working I would suggest only in a more extended way. Cars in the streets of London, then a run at railway speed out into the country or nearer suburbs, then into the streets again.

This suggestion only becomes practicable through the application of electricity to tram and railway work. This motive power has worked something very like a revolution in urban transport. In all the big cities of the world the electric motor is rapidly displacing the steam locomotive and railway after railway is busy electrifying more or less of its urban and suburban roads.

So soon as steam railroads began to get to work engineers began to apply them to city traffic. In London and Paris this was done by means of the "Undergrounds" as the specially urban lines of those cities were soon nicknamed. In spite of locomotives fitted to discharge the exhaust into large tanks, instead of into the air, whilst passing through tunnels, the smoke and heat was a source of great discomfort. In America these disadvantages were avoided, for, in New York and Chicago, lines were built on steel bridges carried along above the street at about the level of the first floor windows. These are called elevated railroads, which imposing title, however, became abbreviated to "the L road." Certainly these avoided the discomforts of underground travel, but they introduced new terrors of their own. The incessant noise was the chief drawback and, if the clouds of smoke did not specially inconvenience the passengers, they certainly were a great nuisance to the houses into whose windows they were carried almost night and day.

Now, however, electricity has changed all that. The smoke nuisance, at least, has disappeared, and with this improvement the underground system now appears to be by far the better of the two. Unsightly street obstructions are avoided and the noise and incessant vibration of the trains are buried out of notice. In the elevated system, on the other hand, these two evils are still present.

But cleanliness is not the only, nor even perhaps the chief gain in electrification, otherwise you could scarcely expect the companies concerned to make so expensive a change. The real commercial gain is rather to be found in the quicker movement of trains, and consequently in the increased number of passengers a given road is able

FIG. 57. A LONDON "TUBE" STATION, EUSTON; CITY AND SOUTH LONDON RAILWAY.

to carry. The great feature of electrical working is the swift acceleration of a train starting from a state of rest. This not only gives a train a much higher average rate of speed throughout its journey, thus enabling it to make more trips in a given time, but it also makes it possible to squeeze in many more trains on to any given section of the line. Thus, for instance, on the London underground lines, trains used to run at from three to five minute intervals over the busiest sections. Now, with electrical working, trains are run at rush hours every two minutes. Thus instead of a possible twenty trains an hour there may be a possible thirty, thus increasing at once the carrying capacity of the road by 50 per cent., without adding extra tracks. Another subsidiary advantage is the quicker and easier shunting possible where about every other vehicle has its own motor, as compared with ordinary cars which have to be moved by a locomotive.

These converted roads were not, however, by any means the first electric railways to begin working either in America or England. In both countries, lines intended from the first to be worked by electricity had been in successful operation for some time before the possibility of a really paying conversion of existing steam roads began to be discussed. In London the first electric railway proper was the City & South London. The first section of this line was opened at the close of 1890, only six years, by the way, after the completion of the inner circle of the underground steam systems. This first section ran from a point just on the north bank of the Thames, close to London Bridge, under the river and then southwards to Kennington and Stockwell, a distance of about four miles. Since then by gradual extensions the line has grown until it now stretches from a

terminus underneath the London & North Western's great Euston terminal to a point as far as Clapham Common.

This line is interesting, not only because it was the first electric railway in London, but because it was built upon a specious but, I believe, very fallacious principle of working which has set the fashion for all London electric lines built since. The principle or idea of working to which I refer was that of getting the line buried out of sight deep down in the earth. Tunnelling was not altogether a novelty, even when the tunnels were intended to be continuous, but it was a novelty to drive these tunnels 60 feet or more below the level of the streets. Of course as an engineering feat it was a splendid achievement, but we are not now concerned with that so much as with the working.

The idea in going down so deep was undoubtedly one of economy, but the result has been that in these tube railways, as they are called, an expensive lift installation is required at nearly every station and not seldom, in addition, there has been considerable outlay for ventilating equipment. London is built nearly entirely on a hard blue clay in which tunnelling is comparatively easy. New York, on the contrary, is built on very hard rock in which tunnelling is so difficult that for years an underground line was deemed beyond the practicable limits of cost. No doubt that fact was chiefly responsible for the building of the elevated, but now the New Yorker has scored in another way. Improved methods of tunnelling have made it at last commercially possible to build underground railways in New York, but not at the depth of the London tubes. Consequently New York will now have, what London ought to have, a convenient series of shallow subways easily accessible.

by steps or even slopes, with no waiting about for lifts and no ventilation difficulties worth speaking of.

Our picture (Figure 57) shows us the Euston terminus of the City & South London. The stations are built in very large tubes about 40 feet in diameter. Lined with bright glazed bricks and brilliantly lit by arc lamps it is difficult for anyone standing on the platform to imagine that he is down in the bowels of the earth. The size of the tubes through which the trains run is also shown in the picture.

This railway's tubes are the smallest of any in London, being only 13 feet 6 inches in diameter. Like all tube railways, the up and down lines are laid in quite separate tubes, which are usually side by side, but which may be one above another, just as the exigencies of space demand. Junctions between the tracks are of course provided at most of the stations.

The City & South London rolling stock is also unique amongst railways. The motive power is transmitted through small four-wheeled electric locomotives, weighing about 13 tons each. They measure 16 feet 8 inches long and 6 feet 10 inches wide over all, the extreme height from rails being 8 feet 5½ inches. They are entered by a door at either end. The cars are of rather a peculiar build, the platform being not part of the car body, but attached to the bogie frames of adjacent cars. The first trains on the line were composed of cars built to the contour of the tube with only a small strip of glass for the windows. Since the opening of the Central London Railway, however, with its smart rolling stock, new trains as shown in our picture have been introduced on the pioneer tube.

These little "Pullmans" are very well proportioned, notwithstanding their small size, and the tiny clerestory

gives quite an airy appearance. All these tube railways have their cars brilliantly lighted and all employ the Westinghouse brake, the coupling hose of which is attached to the roofs of the cars on this railway, as the reader may discern from a close examination of the picture.

With regard to the general question of electric railways it must be remembered that their working is not by any means confined to cases such as these tube and other strictly urban lines. There is a growing tendency, especially in America, and to some extent in Germany also, to extend the area of electric working further and further into the country districts. Of course the commercial possibilities of this are governed ultimately by the density of traffic over the line, which again is dependent upon the density of population in the districts served. There comes a point at last where the population is so scattered and thin that there is no longer sufficient traffic to keep an electric line profitably busy. Here the steam locomotive will still hold sway, unless other special local circumstances should intervene. An example of these last may be found in the Simplon Tunnel where electric working carries the day largely on account of its special suitability for operating the long grades through the tunnel without undue expense in the way of ventilation, such as would be required if the line were worked by steam locomotives.

How far an electric road may spread may be judged from examples like that of the Albany & Hudson Railroad, which duplicates the main line of the New York Central for over 37 miles, working both passenger and freight trains by electricity: or again, like the Toledo & Western Railway, whose main line is 59 miles long.

In this case, however, freight trains are worked by steam traction.

Examples like these have shown that in certain circumstances it may be profitable to face even the tremendous cost of converting a steam road to electric working. We have only space to illustrate one example of this. It comes from a section of the busy Lancashire & Yorkshire which has converted some sections of its suburban lines in and around Liverpool. Our picture (Figure 58) shows a train on the Southport line. Southport is a big town and pleasure resort on that bulge of the Lancashire coast line between the Mersey and the Ribble. One section of the Lancashire & Yorkshire follows the coast more or less closely all the way, Southport, Chapel Street, being 18½ miles from Liverpool Exchange, by this route. All this division of the road has been electrified, and also for three miles beyond Chapel Street to Crossens.

About 120 trains are run each way daily, including fast and slow, so there is evidently room here for the special economies of electrical operation. With the conversion two changes came about in the passenger rolling stock employed. First of all, second-class was abolished, and secondly, cars were substituted for carriages. Our illustration shows a typical train with one first-class car, one third, and two thirds with motor and luggage compartments.

This adoption of cars in the place of compartment carriages for suburban working is a feature of great interest. For years English lines stood out against the car type of coach, one great objection to it being the alleged slowness of passenger movement at stops. Now, however, we find English lines beginning to adopt the car for the

very service of all where this disadvantage should be most felt. It is now being agreed in Britain that the American system was the better after all, and that the movement at stations may be actually quicker with cars having only two end doors than with carriages having a door to each compartment.

The explanation of the paradox seems to lie here, that where there are end-door cars, the porter travelling between can regulate the flow of traffic so that passengers can be leaving by one door while they are entering by the other. At the same time, in a car train passengers do not spend time rushing up and down the platform to find seats. They can enter the train at any door and find seats after it has started. Yet a third reason, subsidiary no doubt, yet still not without weight, is that a certain amount of time is apt to be lost in closing many carriage doors and seeing that passengers wishing to go are safely in. For all these reasons, then, two doors are actually worth more than five.

Between Liverpool and Southport only 37 minutes are allowed to run the 18½ miles, with 13 intermediate stops, the time allowed at each station being only 15 seconds. The Lancashire & Yorkshire recently took count of the time taken to empty a car train of passengers. The observations were made on ordinary trains, unknown to the passengers, between 8.07 A. M. and 9.29 A. M. and between 12.52 P. M. and 2.22 P. M. and in only one case, however crowded the car, did it take more than 60 seconds to empty. This was when 86 passengers took 63 seconds to leave a third-class car with 80 seats. A similar car was emptied of 93 passengers in 53 seconds, and another of 76 passengers in 39 seconds. The average of the whole series of observations works out that 16 passengers leave a car by two doors in 10 seconds. I

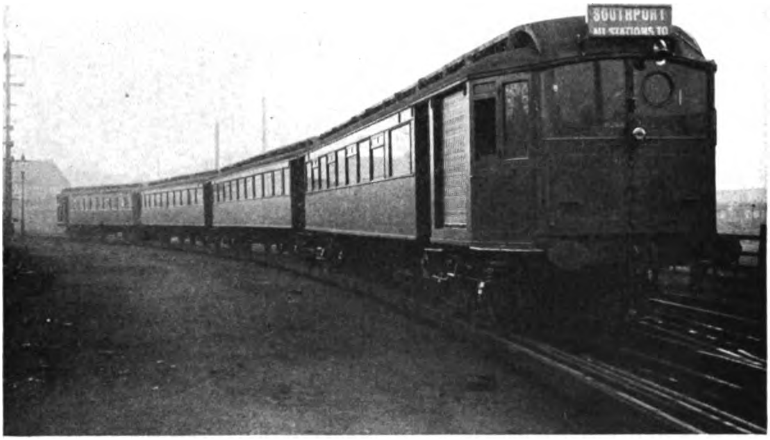

FIG. 58. ELECTRIC TRAIN ON THE LANCASHIRE AND YORKSHIRE RAILWAY.

FIG. 59. STEAM LOCOMOTIVE AND "WIDE" CARRIAGES, GREAT EASTERN RAILWAY.

TWO WAYS OF HANDLING SUBURBAN TRAFFIC.

have extracted the above details from a recent number of the *Railway Engineer.*

The time difficulty being thus got out of the way, let me again emphasise another point which emerges as to the difference between cars and compartment carriages, namely the superior structural strength of the former. This, and the personal safety of the lonely chance passenger at slack hours on out-of-the-way sections of the road, seem to me to be matters well worth insisting upon.

In England the adoption of cars for suburban service has been confined, so far, to cases of electric working. In America, and even on the Continent, cars are used for steam trains in such service. The American cars are of course always on bogies. In Paris, however, many of the trains are composed of little four-wheeled cars. These frequently have very wide platforms designed to afford standing room when required, and indeed are not, strictly speaking, cars, seeing that they do not communicate one with another across the platforms. They present, in fact, a combination of car and carriage, without the good features of either.

Our next picture shows us a London suburban train of the Great Eastern Railway. The suburban passenger movement of this road is probably the largest of that of any big railroad in the world. Their Liverpool Street terminus can and does handle 990 trains and 176,000 passengers in the 24 hours. On the Walthamstow line trains run, never at more than 30-minute intervals, all through the day and night, week in and week out. During the rush hours the number of trains is increased to one every 10 or even 8 minutes. It may be well perhaps to repeat here what I have already said elsewhere, that the real difficulty of this traffic congestion lies in the terminus. Do away with the terminus and your difficulty

largely disappears. Because, you see, for every train that runs into a terminal station, one must also come out, and in coming out must, more or less, cross the track of the one coming in. This rule is not quite so inelastic as it sounds because, by multiplication of platforms, it is possible, for a little while, to have a rapid succession of trains moving one way, without any balancing movement in the opposite direction.

These facts explain the growth of terminals. The expansion is caused by the ever more urgent need to be able to accommodate trains without immediately making room for them by the movement of other trains. As no doubt many of my readers are aware, engineers now think of seeking for relief rather in doing away with the terminal altogether. This has been done, for instance, in the big new Union Station, at Boston, U. S. A. This palatial structure has been arranged on two floors, so to speak. The upper floor forms an ordinary passenger terminal depot and is used for all main line trains, while the lower floor is used for suburban traffic. Trains dip down into it from the main line tracks outside the station and enter it on one side, where they stop to set down their passengers. Then the empty train runs on, without any reversing, round a horse-shoe to the other side of the depot where outgoing passengers are picked up. By this means trains can be kept moving through the station at the rate of 30 an hour if need be, and the main line platforms above are still available for extra trains. Of course a reconstruction upon this wholesale scale means a huge outlay upon existing terminals, but when one remembers the vast sums that, as a matter of fact, have been spent in mere extensions and additions during the last few years, it does seem a pity that the striking and original plan just referred to has not been

more extensively adopted. The idea was, I believe, mooted when the last costly extension of Liverpool Street, London, was undertaken, but apparently was not considered practicable. The Great Eastern, then, like other lines has been compelled to fall back on the locomotive and carriage department to a very large extent in order that, by their ingenuity, the carrying capacity of the road as it stands may be increased to the greatest possible extent.

For moving their suburban traffic the Great Eastern use three classes of tank engine. One is a 2-4-2 tank with 5 feet 6-inch drivers: another is a 0-4-4 engine with 4 feet 11-inch drivers, and the last is the one shown in Figure 59, a 0-6-0 engine with 4 feet 6-inch wheels. The first class are chiefly employed on longer runs, the other two classes on trains stopping at all stations, though of course no absolute distinction is made. Engines of the type illustrated in our picture are nearly always to be found on trains working to Enfield. From Liverpool Street to Enfield Town is 10.75 miles, and though there is not an all-night service as there is on the Walthamstow line, yet there is only a gap of four hours and a half between the trains of one day and those of the next.

Like most other British lines the Great Eastern mostly use 4-wheeled carriages for their suburban service. These are built sufficiently wide to accommodate six passengers a side instead of the usual five, that is, each compartment seats 12 instead of 10. This represents a total gain in carrying capacity of 20 per cent. for second and third classes. The firsts seat five instead of four, a gain of 25 per cent. These carriages are 9 feet wide and to utilise space as much as possible the interior panelling is wanting above the level of the seats, thus affording a few inches extra elbow room.

The train in our picture, however, consists of 8- and 12-wheeled bogie carriages. The dimensions of these are respectively 46 feet and 54 feet in length and 9 feet wide over all. The train has a total seating capacity of 808. The bodies are of teak with side panels of galvanised steel plate. My readers will notice that the bogies of these coaches are of an American type with helical springs and equallisers. Both the bogie frames and the carriage underframes are of steel. The doors are recessed, and fitted with rounded tops in order to lessen the risk of fouling when open. The train is lighted by electricity on Stone's system and measures 430 feet over all.

For our next example of suburban service we will turn to the important Chicago system of the Illinois Central. This road has two main suburban divisions, one extending along the main line to the south, as far as Flossmoor, 25 miles out, the other on its main west-going line for 24 miles to Addison. There are of course other shorter routes, but these need not now concern us.

My readers will notice that we are now beginning to deal with gradually extending suburban services. Indeed, the American business man thinks far less than the average Englishman of making a long journey to and from his office every day. To handle this large suburban traffic the Illinois Central have put into service trains composed of the interesting type of stock which is illustrated in Figures 60, 61, and 62. Figure 60 shows us a single car of the new type designed by Mr. William Renshaw and built in the company's shop at Burnside, Chicago. These cars are a remarkable combination of British and American practice. As Figure 60 shows, they are provided with side doors even rather more plentifully than an English compartment carriage. These doors, however, unlike the British type, are not swinging,

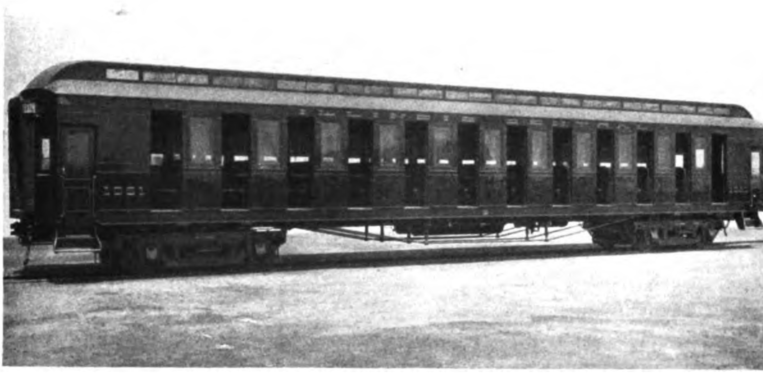

FIG. 60. EXTERIOR, SHOWING SIDE DOORS OPEN.

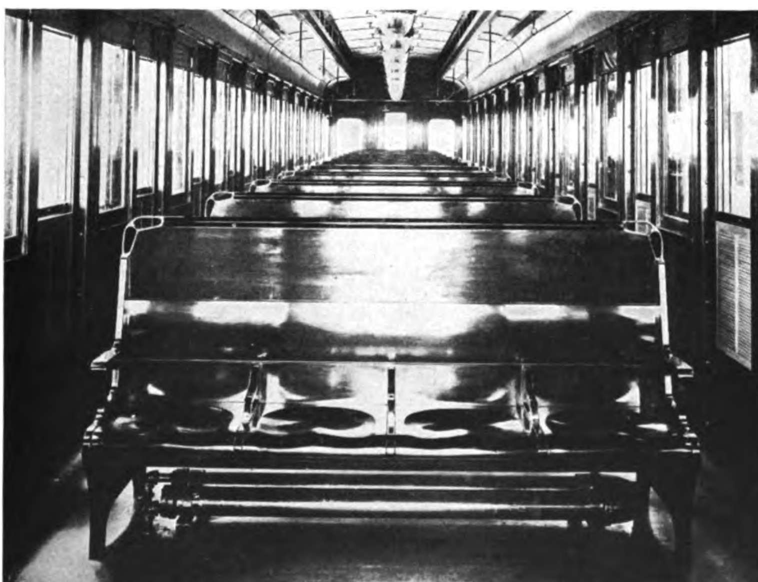

FIG. 61. INTERIOR.

HOW THE SUBURBAN PROBLEM IS SOLVED BY THE ILLINOIS CENTRAL RAILROAD

but sliding doors. They are moved by means of compressed air, derived from the same source of supply as the power taken to operate the brakes, and all the doors on either or both sides simultaneously can be opened by the porter at either end of the car. At the same time they are provided with ordinary American end doors so that, when working on trains running a fair distance without a stop, the usual method of operation can be resorted to, and the side doors kept closed.

From this it will be guessed that the interior arrangements of these cars are decidedly different from those of an English compartment carriage. There are, indeed, no partitions, there being merely 11 double seats placed back to back, each holding four persons. At either end an extra seat is provided accommodating four people on one side and two on the other. There are thus virtually the equivalent of 12 compartments, providing seating accommodation for 96 passengers, or, with the two double seats at either end, 100 in all. As will be seen from Figure 61 an aisle runs down both sides of the car. As I have already shown in this chapter, and as the experiments conducted by the Lancashire & Yorkshire conclusively prove, the ordinary American end-door car admits of decidedly quicker passenger movement than the British compartment carriage.

These new Illinois Central cars, however, though equipped with side doors, have been designed with the view of obtaining whatever advantage there may be in the multiplicity of side doors without their attendant disadvantages. Thus, for instance, in a train made up of these new cars, a passenger need not waste time in looking for a seat, but may, as in the ordinary American car, board the train at any point, and find his seat after it has started. As will be seen from the picture the cars are

vestibuled so that a passenger can move to any part of the train when once he is inside.

On the other hand, no time is lost in exit at stations, because all the doors, if need be, may be simultaneously opened. Another advantage in the cars is the absence of the dangerous English swing-door, which, when allowed to swing open as a train is entering a station, often imposes considerable risk on passengers standing on the platform.

The only great disadvantage in this type of car seems to be that the cutting of doorways in the car body introduces the same element of structural weakness which is involved in the English compartment carriage. This of course can only be met, as it is met in the English carriage, by introducing the requisite strength into the underframe. From what we have already learned in Chapter III., we shall, I think, agree that even an underframe can scarcely be made to compensate for the absence of the trussed side.

It is a very interesting example of the interchange of ideas, that at the very time when British railways are coming more and more to adopt the American end-door car, there should be in America the striking movement towards the English side-door system which this Illinois stock represents. And, just as we saw in Chapter III., that the combination of English and American ideas had resulted in the nearly perfect compartment car for long-distance travel, so it seems permissible to regard this other combination of constructional ideas from both sides of the Atlantic as resulting in a nearly perfect form of vehicle for the special needs of suburban service. This of course does not mean that these cars are above criticism. Some form of parcel rack seems to be required, and it will possibly also be found that the raising of the

FIG. 62. TAKING HOME THE CHICAGO BUSINESS MAN, ILLINOIS CENTRAL SUBURBAN TRAIN.

backs of the seats will be an advantage. In this latter respect, however, we must remember that the seats are about the height to which the American traveller is accustomed.

Now for the actual build of the cars. Steel is used largely throughout. The under-frame consists of four 9-inch steel beams, the section of which forms roughly the capital I. These beams are 64 feet long, and are spaced at nearly equal distances apart, so as to afford a total width over their flanges of 10 feet 4 inches. The end sills, also of course of steel, are of the same cross-section as the longitudinal beams. The sills and beams are riveted together by double angle plates and gussets. The usual stiffening pieces are introduced between the longitudinal beams at intervals somewhat after the manner of the cars we have already studied in Chapter II.

An important item of strength is introduced by a floor of steel plate which is laid on the under-frame. These plates are each 5 feet wide and ¼ inch thick. The Illinois Central's standard passenger trucks are used under the cars, and are of a normal American type. The wheels are 2 feet 9 inches in diameter. The bogies have a wheel base of 8 feet each and are spaced 48 feet ½ inch apart centre to centre.

The body frame is also of steel, and steel braces are introduced in the panels between each pair of side doors. The floor is laid in three courses. Above the solid steel floor, which I have already mentioned, comes a layer of asbestos ¼ inch thick, and upon this a wooden floor is laid crosswise in tongued and grooved strips, being bolted to the steel floor underneath. The seats or benches are made of mahogany modelled more or less to the human shape. No upholstery is used, but the seats are mounted on springs. The cars are lighted by gas, and warmed

by steam in the winter. A feature in the side walls of the cars is that the glass panels are carried up to such a height that it is possible for a passenger, even when standing upright, to look out of the window without stooping. Of course, as on most suburban lines, during the rush hours, as many people are carried standing as sitting. The total weight of one of these cars is 37.5 tons English. Figure No. 62 shows a train of these cars, running between Chicago and Flossmoor. This train will have a weight of 225 tons, a total length of about 432 feet over the end vestibules, with a seating capacity of 600 passengers, and standing room for nearly as many more. The locomotive is a front coupled tank engine with a leading pony truck, and a six-wheeled trailing bogie carrying coal bunker and water tank.

From Chicago, a city of heavy suburban traffic, let us now turn to Edinburgh, where the traffic is much lighter, but where, nevertheless, the enterprise of the railway companies has spread it out over a considerable distance. Figure No. 63 shows us a suburban train standing in the station at North Berwick 22½ miles from Edinburgh, Waverley, or about the same distance as Flossmoor from Chicago in the same example which we were last studying. Instead, however, of a road driven to provide cars of an exceptional type and carrying capacity by the density of the traffic, we find here the North British Railway content to use its ordinary main line stock for the suburban traffic. The explanation of course is, that, leaving out of sight the difference between the size of Edinburgh and Chicago, the Scottish capital is really still, to a very large extent, itself a residential town, and the railway companies which serve it are only beginning to build up a suburban traffic by the facilities which they offer.

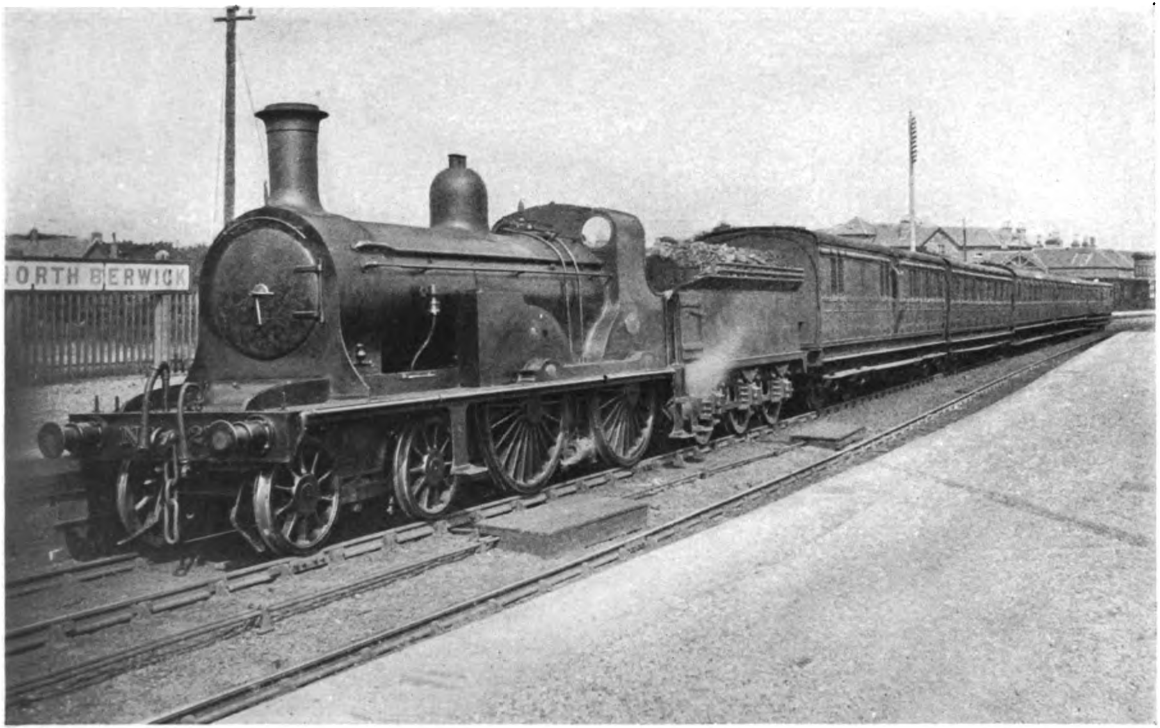

Fig. 63. Waiting for the Golfers.

North British Morning Train to Edinburgh in North Berwick Station.

The little Scottish coast town looks out on the blue waters of the Firth of Forth, and as you step out of the station at night, you are greeted by the flash of the distant light away on May Island. Beyond the town, to the south-east, lies a romantic coast crowned by the ruins of Tantallon Castle. From this quietude the North British fast train will land you into the heart of Edinburgh, alongside the platforms of the huge new Waverley station, in 49 minutes.

I began this chapter with some consideration of the suburban services of the biggest city in the world, and for a close let us turn back again to one of the long-distance suburban services which the Londoner is just beginning to learn how to use. Figure 64 shows us the new Pullman Limited train recently put into service by the London, Brighton & South Coast Railway. I am not quite sure whether either the railway or the Pullman Company will be pleased at having their "Southern Belle" described as a suburban train, but as a matter of fact, the London, Brighton & South Coast Railway have been striving for some time now to make Brighton really a suburb of London. So long ago as 1858 they began running a service of 70-minute expresses, and for the last 50 years the number of season tickets issued between London and Brighton has been steadily growing. The new Pullman train inaugurates a 60-minute service. This train, as will be seen from the picture, consists of seven 12-wheeled vestibuled cars. Each car measures 63 feet 10 inches long over the vestibule face plates, and 8 feet 8¾ inches wide over all. The height is 8 feet 6 inches from floor to roof, and each car weighs about 40 tons. The whole train thus weighs about 280 tons and affords seating accommodation for 219 passengers. We may contrast this with the 600 passengers accommodated by

the 225-ton Illinois Central train described earlier in this chapter. The "Southern Belle" is a limited train for first-class passengers only. As some set-off against this, however, it must be remembered that the first-class season or commutation ticket between London and Brighton is only £30 a year, or about twelve shillings per mile per annum. In other words the rate paid by a first-class passenger taking the cheapest season ticket available works out at a little less than a halfpenny a mile, or half the ordinary third-class fare. One can scarcely help reflecting that, if it be profitable to the company to carry passengers at this rate in a train like the "Southern Belle," it would surely be much more profitable for them to be running well-filled trains of third-class season ticket-holders between the same points. We may put it in this way: a 22-ton bogie carriage will provide seating accommodation for 80 third-class passengers. This means that a car of the same weight as one of the "Southern Belle" coaches would accommodate 145 passengers, instead of the 33 which are carried in the most fully occupied of these magnificent Pullmans. This is more than four times as many passengers per ton. The conclusion then seems irresistible, that if it pays to carry the £30 first-class season ticket-holder in a train like the "Southern Belle" it would be even more profitable to carry third-class passengers for a season ticket of £7, 10s. a year.

These figures appear to show two things. First of all, how large a field of profitable traffic is being left unexploited, and secondly, how much might be done by the railway companies themselves to help in solving the serious problems presented by the enormous congestion of population in the great cities of the world.

The most striking feature about the "Southern Belle" is that the clerestory roof which has, ever since Mr. Pull-

man built his first car, been a distinctive feature of the vehicles bearing his name, has now disappeared and given place to an elliptical roof, such as is now very much used in England and on the continent of Europe. The interior of stock built on this pattern perhaps appears less light and airy than where the roof is of the clerestory style. But, as a matter of fact, the air space in a coach of given size is greater because the space included between the angle of the clerestory and the lower roof is thrown into the interior of the car instead of being left outside. The cost of construction in a roof of this pattern is also appreciably less, because of the greater simplicity of the design.

Our picture shows the train being hauled by one of the new express tank engines which Mr. Marsh has recently introduced on the line. These engines have 6 feet 9-inch drivers, cylinders 19 x 26 inches, a boiler 4 feet 10 inches in diameter and affording a total heating surface of 1623 square feet. The total weight of the engine in working order is 73 tons, of which the drivers carry between them 38 tons. No. 19 differs from the first of her class in having a slightly extended smoke-box fitted with a Schmidt super-heater, and also in having the bogie wheels braked.

The examples of urban and suburban service which we have studied in this chapter have been, of course, more or less isolated, but they are, I hope, sufficiently representative to show us that the car-builder finds in this department of his work problems which afford him a considerable field for the exercise of his ingenuity. Railways are faced just now by serious competition from the tramway services which are being so rapidly brought to perfection in and around all-important centres of population. For certain classes of very short-distance traffic

it is impossible that the railways can successfully compete with the trams. The true usefulness and, therefore, the true profitableness, of the railway depends rather upon its transporting at a higher rate of speed than is possible for a tramway service, and over greater distances.

With methods of railway operation as they are to-day it ought to be quite possible for the companies to afford facilities to their customers which shall enable them to live as much as 50 miles away from their business. In so doing, they would build up, not only their own passenger traffic, but also indirectly their goods traffic, by helping to create flourishing townships at places at present but thinly populated. This is a point which seems to be too generally overlooked. The companies often still vainly endeavour to fight the tramway companies in providing facilities between distinctively urban districts and the centre, thereby crowding their lines with trains from the running of which the profit tends more and more to disappear, and preventing themselves from being able to afford those greater facilities for places further afield which would repay them both directly and indirectly. Even the 60 minutes' Brighton service of the "Southern Belle" does not mean that the great majority of people whose work lies in London could live so far as 50 miles away. The second- or third-class passenger, who requires to be in the city by nine o'clock must leave Brighton not later than 7.35, and the cheapest season ticket of which he can avail himself is the £28 second-class ticket, no third-class seasons being issued.

I cannot help trying to emphasise the fact that, not only for the Brighton, but for most other companies, there lies ready to hand a profitable but almost untouched field of traffic development which may be reaped by any line having the courage and the enterprise to run reasonably comfortable and fast trains at cheap rates.

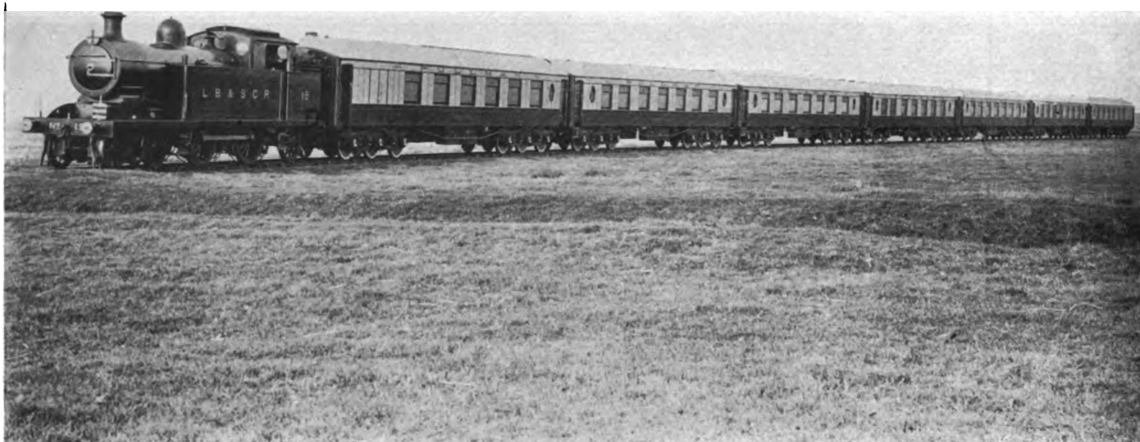

FIG. 64. THE QUEEN OF THE SUBURBAN SERVICE. THE LONDON, BRIGHTON, AND SOUTH COAST'S "SOUTHERN BELLE."

VI

Rail Motors

In this chapter we turn from the consideration of suburban services to talk for a little while about a very different kind of traffic. We come from the crowded centres of the population to those outlying districts where people are so thinly scattered that it becomes hardly profitable to run passenger trains of the ordinary type. Some lines with a very limited passenger movement have, in days gone by, been worked by means of horses.

One of these little lines was the Swansea and Mumbles Railway which extends along the shore of the beautiful Swansea Bay for nearly five miles to the Mumbles lighthouse. This line is now incorporated with the Mumbles Railway and Pier Company, the new organisation being known as the Swansea Improvements and Tramway Company, the whole of the traffic of which is now worked by electricity. During the steam period of this line long trains of passenger carriages drawn by two engines were sometimes to be seen in the streets of Swansea during the summer.

When the Weston-supĕr-Mare branch belonged to the Bristol and Exeter Railway, it was also worked by horses, the train usually consisting of three 4-wheeled coaches as small and light as they could be built, considering that the line was broad gauge, and drawn by 3 horses, each ridden by a postillion. There were no shafts for the leading carriage, and no adequate brake power, consequently the work was very dangerous both for horses

and the lads riding them. It is curious that the horse-trams were continued even after an express through to Bristol, drawn by a locomotive, had been begun. Another instance, in some respects more remarkable, was provided by the Midland line. Southwell is a cathedral city, and was served by a little branch line 2½ miles long, opened in 1847. The city, however, is so small that the provision of a branch worked by steam was found to be a very costly and ruinous proceeding. The steam locomotives were therefore withdrawn, and about the end of 1848 horse traction was substituted. Later on, the line was closed entirely until an ordinary train service was resumed in 1860. A more recent and probably, at the time of writing, a unique instance of a horse railway, is that afforded by a little out-of-the-way branch of the North British. On the south of the Solway Firth this railway has a 22½-mile branch between Carlisle and Silloth. From Drumburgh a little sub-branch about 3 miles long runs down to Port Carlisle. This branch was, at any rate until quite recently, worked by a train consisting of one small 4-wheeled coach drawn by a horse. The coach has a very narrow body and is reached from the ground by two wide steps coming out over the wheels. A dash-board is fitted to either end of the under-frame which projects beyond the body, so as to allow the driver standing behind the dashboard to handle the reins. The passengers' luggage, when there is any, is still carried on top of the coach, around which a light iron rail runs to prevent it falling off.

Nowadays, however, lines of this description are quite frequently worked by what are known as rail motors. A rail motor coach is by no means a novelty; in fact in the early days of railroading, both in America

and Great Britain, passenger cars, built upon an extension of a frame of a locomotive, were not unknown. These were all of very small size. One little coach of this description ran on the Eastern Counties Railway, now part of the Great Eastern. It was carried on 6 wheels, of which the middle pair were the drivers. The idea has been revived of late years, the pioneers of the movement in America being the New York Central, and in Great Britain, the North Eastern. The North Eastern motor car services, however, have their origin not so much in the lonely parts of the line, as in the congested districts of the north-east coast shipping ports, such as the Hartlepools. Here they were faced by very vigorous tramway competition, and the rail motor had its original conception in the idea of a tramcar run on the railway. The adoption of these autocars was really a desperate attempt to avert the costly process of electrification to which it was the only practicable alternative.

The problem set before the North Eastern engineers was to provide a frequent service in a district where a frequent service of trains of the ordinary type involving a good deal of shunting, and the employment of the usual train hands, and station hands, could not be expected to be profitable. Leaving this instance on one side, however, we shall find that the great majority of cases where the rail-motor car has been employed have been in quite out of the way districts. Two methods of working the rail motor are common; one of them is to have the motor itself as an integral part of the vehicle, and the other, to have it in the form of a separate locomotive. The former of these two methods was generally employed at first, but has been found to involve this disadvantage that in the event of any repairs being required to the motor, it necessitates throwing the whole vehicle out of service until the

repairs can be completed. Of late, therefore, there has been rather a tendency to resort to the second method of propulsion, in which the locomotive is a separate vehicle altogether. For this purpose some engineers have designed very small tank engines, such as can be profitably used in propelling a train consisting of not more than usually one or two 20 to 25-ton coaches. The most conspicuous example of this has been some very tiny 4-wheeled tank engines designed by Mr. Drummond for the London South Western Railway. Other companies, however, even when the plan of building special engines has not been adopted, have found it profitable to employ in services like these old and small engines which were no longer capable of dealing with the growing weight of ordinary trains. Figure 65 is an example of this. It shows us a modern passenger car built by the London, Brighton, & South Coast Railway coupled to one of Stroudley's old "terrier" type engines. These engines were orginally 6-coupled side tanks, but the one in our picture has had the front coupling rods removed, and a pair of small carrying wheels substituted for the leading drivers. In its new guise it is therefore a 2-4-0 tank. When running engine foremost the driver works his locomotive in the ordinary way standing on the footplate with his fireman. When, however, after coming to the journey's end, the motor train has to proceed in the opposite direction the engine is not uncoupled, but the driver simply takes possession of a compartment set apart for him at the extreme end of the passenger car away from the locomotive, and drives his engine from there. The engine is now, of course, pushing instead of pulling the car.

To enable this to be done, the engine regulator is duplicated in the driver's compartment of the coach, the two handles being connected by a system of levers pass-

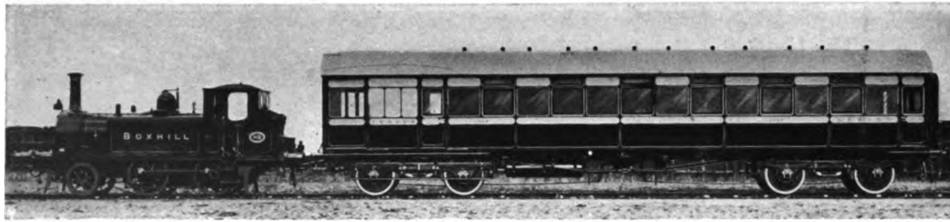

Fig. 65. An Old Engine on a New Service.
Steam Rail Motor for the London, Brighton and South Coast Railway.

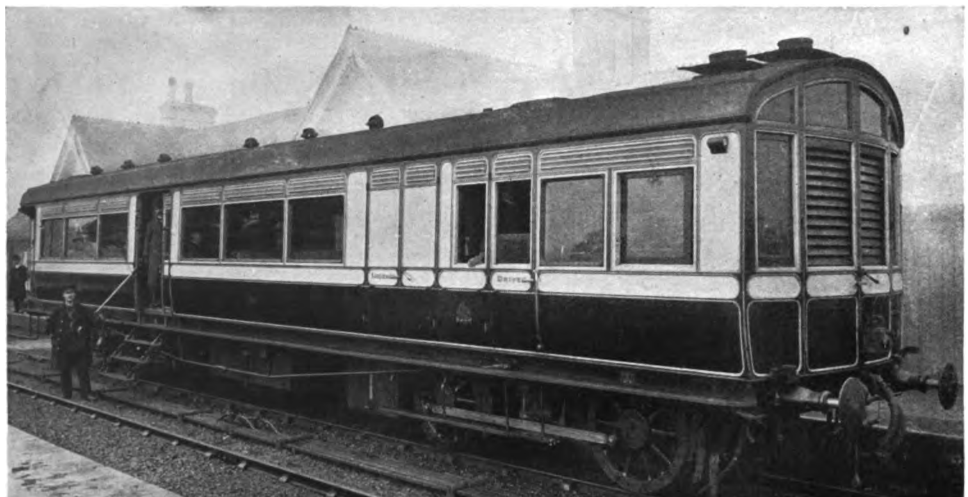

Fig. 66. A Self-contained Railway Motor Car, London and North-western Railway.

ing underneath the coach, and coupled with the levers from the engine cab by means of a universal joint, thus allowing for going round curves. The air-brake is, of course, easy to manipulate from the driver's compartment, because there is always provision made, as we shall see in the next chapter, for the guards to have control over the continuous brakes on any train. When travelling in this reverse order the fireman still rides on the foot-plate of the engine, and attends to his fire, and also to the notching up of the reversing lever, and the consequent expansive working of the engine. This car seats 52 passengers in two compartments, smoking and non-smoking, and can also carry, if need be, a considerable amount of luggage or parcels. One porter can adequately take charge, and so three men suffice for the whole train, including the locomotive crew. There is thus not much gained in the number of hands required on a train, for local trains in England frequently run with only one guard. Where, however, it is possible to make some gain, is in the substitution of what are technically known as halts in the place of regular stations.

At these "halts" nothing is provided but a tiny platform and a seat, and possibly a shelter of some kind. There are no booking offices, and no station staff is employed. When the motor comes along, the porter in charge issues a ticket, and performs all the necessary station duties that may be required. This has enabled facilities to be provided at several points where the traffic would not justify the equipment of a station, but where yet there may be little groups of cottages or houses from which occasional passengers may be picked up.

Our next picture on the same page (Figure 66) shows a motor car for the London & North Western Railway. This is built with the engine as part of the car itself.

The rear end of the car is carried on an ordinary carriage bogie, the front end of the car in the picture is carried on a small bogie consisting of a pair of coupled driving wheels. The car in question has, as will be seen from the picture, inside cylinders, but in most rail motor cars the cylinders are arranged outside, and equipped with Walschaert valve gear as being more readily got at if need be on the road than the ordinary Stephenson link motor. This car, of course, can also be driven from either end. Our picture shows the car standing in the station, but it also shows an interesting detail of its equipment which enables it, if necessary, to stop, and take up passengers even at a level crossing. This consists of a set of steps on either side of the car, which, when running, are folded away beneath the under-frame, but which can, with a turn of the hand, be brought out, and set as shown in the picture. In cars like those built for the New York Central, for instance, this special provision is not necessary because the ordinary end steps of the car suffice. This car was built for service on the branch line between Bletchley and Oxford.

Figure 67 is a steam-motor car designed by Herr Gölsdorf for service between Vienna, Florisdorf, and Ganserndorf, on the Emperor Ferdinand's Northern Railway. This line connects with the Austrian State Railways at Cracow. Ganserndorf is only 19¾ miles from Vienna, however, and it is for this suburban service that the steam car shown in our picture has been designed. Like the London & North Western example which we have already studied, the engine and car form only one vehicle. Unlike it, however, Herr Gölsdorf's design runs on four wheels only, one pair of which form the drivers, and the other a pair of carrying wheels. The car is warmed by steam, lighted with acetylene lamps,

and will seat 40 third-class passengers. Steam is supplied from a water-tube boiler having a heating surface of about 323 square feet. The engine itself, like all of its designer's recent build, is a compound. Herr Gölsdorf stands almost alone among locomotive engineers in building such small engines as these on the compound system. The high-pressure cylinder is only 9¾ inches in diameter, and the low-pressure 15¼ inches, both having a stroke of 15¾ inches. The boiler is constructed to stand a working pressure of no less than 270 pounds per square inch. The car weighs, in working order, about 26 tons, English. There is thus more than twice the normal weight per axle of an ordinary passenger car.

A feature in the working of these cars is that they are frequently used to haul ordinary passenger stock, and even goods wagons. The end-door steps provided on this car are similar to the usual Continental and American practice. English engineers are almost alone in providing high station platforms built up to the level of the carriage floors. Even on the main lines of a railway like the Northern Railway of France you may see stations with not only extremely low platforms, barely raised above the level of the rails, but these platforms themselves, in many cases, not even faced. The step provision, therefore, which is quite an exceptional feature in English car design, is the normal rule of passenger stock of most other countries. Like most rail-motor cars, the one in our picture provides for only one class of passengers, carried in two compartments, smoking and non-smoking. Some English companies have adopted types of rail motors, however, in which provision is made for carrying both first- and third-class passengers.

Our last example of a rail motor is a little 4-wheeled car built for the Kent & East Sussex Railway. This

light railway, which connects the South Eastern main line at Headcorn with its Hastings branch at Robertsbridge, although operating only 24 miles of rail, is yet wonderfully modern in most of its rolling stock, and the little car in our picture shows that the company is not afraid to make experiments. Like the Austrian example at which we have just been looking, it runs on 4 wheels, but unlike it, is driven by a pair of simple cylinders, each 5½ inches in diameter. The engine does not drive direct, but through the medium of a driving shaft and pitch chain on to the axle under the end at which the boiler is carried. The boiler is of the multitubular type and placed vertically so as to economise space. Seating accommodation is provided for 37 passengers all told, and there is also standing room for a few in addition, if need be. The large compartment at the end, furthest from the engine, is specially provided for the carriage of milk churns. The Kent & East Essex Railway serves an almost purely agricultural district, and the special provision which has been made in this car in this direction is typical of the conditions under which it works. Twelve to fourteen churns of milk, in addition to a certain amount of ordinary baggage, can be carried. This car was built by Messrs. R. Y. Pickering & Co., Ltd., of Wishaw, near Glasgow.

The revival of an old idea, which has come to light again in these rail motors, has made itself felt nearly all over the world. The most common type which has been put into service is the one more or less represented by the example which we have taken from the London & North Western stock. English rolling stock builders have been busy during the last few years in supplying these cars, not only to nearly all the English railway companies, in addition to what the latter have built in

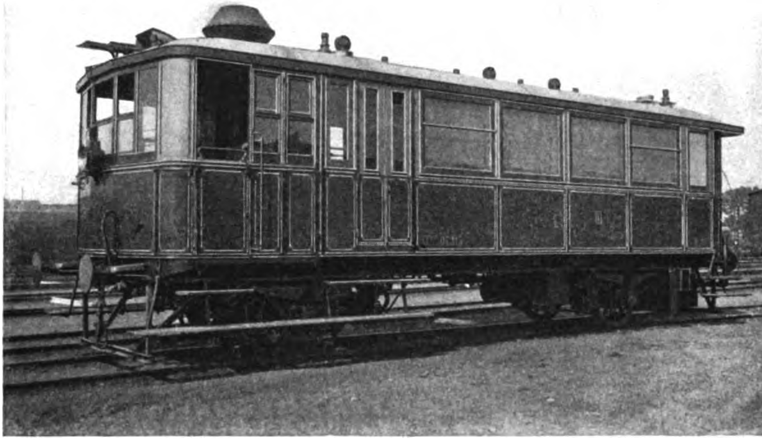

FIG. 67. EMPEROR FERDINAND'S NORTHERN RAILWAY.

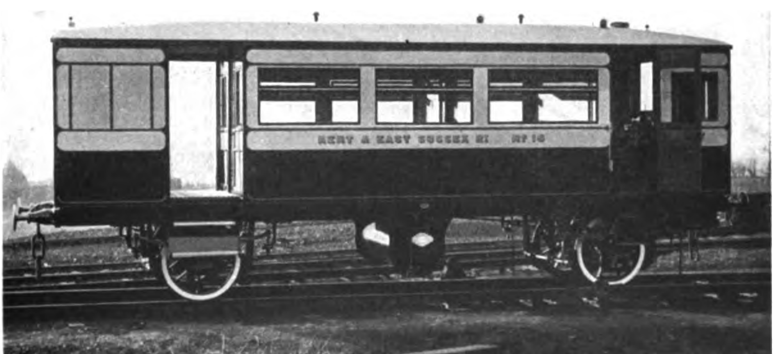

FIG. 68. KENT AND EAST SUSSEX RAILWAY.

FOUR-WHEELED RAIL MOTORS.

their own shops, but also to many of the Colonial lines in different parts of the world.

These cars afford another example, a tendency to which I have already called attention, for the operating, or traffic department, as it is called in England, to make their unit, not the individual car, but the train.

In the further almost irresistible tendency apparent wherever these rail motors come into use, to arrange them for one class of passengers only, there is another instance afforded us of the gradual, but practical, breaking down of the old English class system.

VII

Other Passenger Business

Besides the two main divisions of railway earnings into those received from passengers and freight respectively, there are also a large number of sundry receipts which do not properly come under the head of either, but are usually classified according to the kind of train by which the money is earned. As a matter of fact, these sundries almost entirely represent the earnings of passenger trains, and they therefore fall to be considered here. They include receipts from the carriage of mails, from horse and carriage traffic, all of which belong rather to the passenger side, on the one hand; and then, belonging to the goods department, there comes the carriage of milk, and in special cases, other perishable commodities, including certain kinds of fruit, all grouped under the generic head of parcels. About these various kinds of traffic, especially as they concern the rolling stock departments, we will now try to gain some information. Figure 69 shows us the London & North Western Irish Mail just emerging from the echoing tubes of Stephenson's famous bridge over the Menai Straits. Away in the extreme north-west of Wales, and separated from the mainland by these beautiful Straits, lies Anglesey, and at the north-west corner of this island in its turn lies the little barren islet still called Holy Island. Here the Druids made their last stand against the advancing Roman civilisation, and to this once lonely spot every day come the North Western Expresses from Euston,

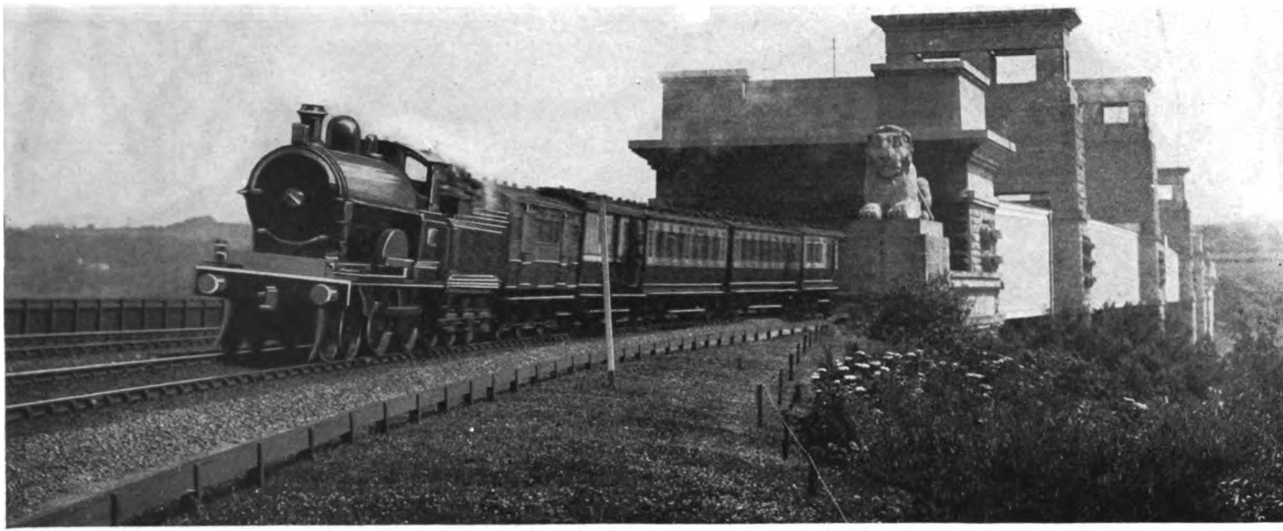

FIG. 69. IN THE LAND OF THE DRUIDS.
IRISH MAIL LEAVING THE BRITANNIA TUBULAR BRIDGE, MENAI STRAITS.

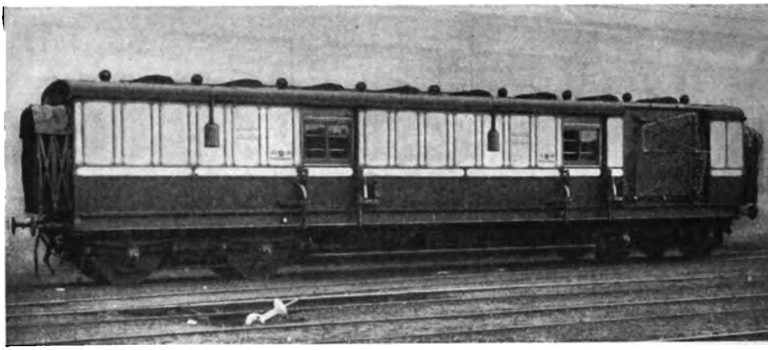

FIG. 70.

FIG. 71.

HIS MAJESTY'S MAIL.

FIG. 70. WEST COAST JOINT STOCK POST OFFICE VAN, WITH NET CLOSED.

FIG. 71. LONDON AND NORTH-WESTERN VAN, SHOWING POUCH AND NET READY FOR AN EXCHANGE.

carrying mails and passengers to be conveyed across the sixty miles of stormy Irish Sea, not only to Ireland, but also for the great lands lying out beyond the Atlantic.

The Irish Mail, as its name implies, is chiefly concerned with the carriage of postal matter destined to pass beyond the sea to Ireland, and America, but it also to some extent, and the other mail trains of the London & North Western Royal Mail route to a very large extent, are taken up with what we may call local post-office business. Much of the sorting is done on the train while running, and both the Irish Mail and the Limited Mail scatter postal communications all along their journey, and also gather up as they go, letters brought from towns and villages near their line of route.

To enable this to be done without imposing an undue number of stops on the mail train, the carriage department, many years ago, devised the extremely ingenious apparatus shown to us in Figures 70 and 71. Figure 70 shows us a postal van for the West Coast Joint Stock, working, that is to say, between London, Euston, and the great cities and towns across the border. In Figure 70 we see a van as it appears in running order, but in Figure 71 we see a precisely similar van with the apparatus for picking up and delivering the mails ready for work. Figure 71 represents a London & North Western van, such as appears also in our picture of the Irish Mail, but the two vans are identical in arrangement and dimensions, indeed in everything except the name. If my readers will examine the two pictures, Figures 70 and 71, which appear on the same page, they will be able to obtain a good idea of what the apparatus consists in, and what are the principles upon which it works. Two wide sliding doors are provided on each side of the van, equidistant from the two ends. At station stops these

doors can of course be utilised for loading mail bags direct from the platform in the ordinary way, but when an exchange is to be made as the train is running the door nearer the net is the one which alone is brought into use. For the safety of the postal employée, whose duty it is to attend to the exchange of mails, the doorway, when the door is open, may be protected by a light iron bar as shown in Figure 71. Swung on a pivot, worked from this door, is a short steel rod projecting downwards and furnished with a hook at the end. Upon this hook is hung the pouch in which have been placed the bags containing the letters to be delivered. As the train sweeps along, this pouch comes in contact with a piece of ground apparatus, to be presently described, which snatches the pouch from off the hook.

Another wide opening is provided just behind the doorway from which the pouch is hung. From this opening a stout net, arranged on a hinged frame, is provided. On the ground apparatus already referred to, the postman has hung his letter pouch containing letters to go by the mail, and when the delivery arm of the ground apparatus is swung into its right position, at right angles to the track, the steel frame of the van net picks up the pouch from off the standard, at the same moment that the delivery pouch is taken from the travelling van by the ground net.

Of course in trains travelling at a high speed the shock of a heavy pouch being flung into the postal van is considerable, and great care has to be taken that no one is near the opening through which the pouch will descend so long as the net is extended. Special attention is also involved on the part of the carriage builder to the structural strength of his car with a view to withstanding the hard knocks involved in this service.

The ground apparatus consists of a receiving net woven of very stout rope, spread out by means of uprights about 5 feet high in such a position that the net will be able to get fairly hold of the pouch as it comes swinging along at the side of the train. The delivery part of the ground apparatus consists of a stout iron post, the top of which is bent over at right angles, which may be turned by means of a swivel, so that the arm is either parallel with the track or at right angles to it. When not in use the arm is turned into position parallel with the track so as to be removed from the risk of striking passing trains.

Figure 72 shows us the same Irish Mail just about to effect an exchange of pouches. The ground apparatus is always arranged at some convenient spot a little away from a station to which the postman may bring his letters some time before the train is due to pass. A little cabin is often provided at the side of the line in which he can shelter while waiting for the train in bad weather.

Some arrangements for the exchange of mails, similar to those first introduced by the London & North Western, are in vogue on most of the chief railways in the world.

The work of a sorter on one of these traveller post-offices is one requiring a good deal of physical endurance, and also one which involves a high degree of intelligence. The sorter must be intimately familiar with the geography of his own country and oftentimes with the geography of foreign countries also. In the United States postal service, for instance, there is involved a knowledge of the postal routes covering the whole of that immense territory. Similarly, on the Continent of Europe, the sorter in the travelling post-office will have passing through his hands mail matter for every state on the Continent.

Our next two illustrations give us an idea of the interior of two typical mail vans. Figure 73 shows us the interior of one of the vans for the London & North Western at whose exterior we have already been looking. Figure 74 shows us an interior of a sorting car for the Imperial German mail service running on the Prussian State Railways. Unlike the London & North Western examples, this coach is not vestibuled and is not provided with a pick-up apparatus.

In both cases, however, we have a similar arrangement of pigeon-holes and letter racks suited to the varying conditions of the service. This Prussian State Railway van was built by the Breslau Railway Wagon and Machine Company.

Two more classes of what the English railways combine under the term of parcels traffic are brought before us in our next pair of pictures. Figure 75 represents a large bogie truck for the London & North Western Railway, designed for light, bulky articles, such as theatrical scenery. This low-sided wagon is 42 feet long and designed to carry a weight of 6 tons. It is equipped with air and vacuum brakes, and screw couplings, and otherwise presents the typical features of standard passenger stock running gear. Figure 76 is a large bogie milk van for the Great Western. The Great Western has the largest milk traffic of any of the lines running into London. This van is built of such a height that one churn can stand on top of another, thus being able to carry two rows of milk churns between the floor and the roof. Like the North Western truck just described, this van is also adapted for running in passenger trains. The bogies are, however, not the standard Great Western passenger type truck, but are built with steel frames of a somewhat different design. The upper portion of the sides

FIG. 72. THE IRISH MAIL PICKING UP.

FIG. 73.

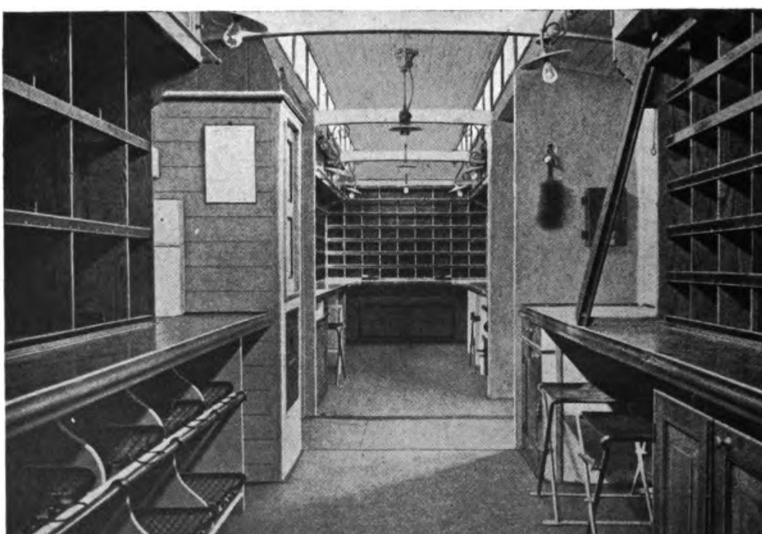

FIG. 74.

TRAVELLING POST OFFICES.

FIG. 73. LONDON AND NORTH-WESTERN RAILWAY.

FIG. 74. PRUSSIAN STATE RAILWAYS.

is louvred to permit of the free circulation of air through the vehicle. Vans similar in general features, though representing of course the typical American details of equipment, are run by the Erie Railroad, whose milk traffic into New York is very much what the Great Western's is into London. Some recent 53-foot milk cars built for the Lehigh Valley Railroad have, like the Great Western car in our picture, a double roof, but are built with ordinary tongued and grooved body panelling, and equipped with a door at the end, through which those in charge of the traffic can, if need be, pass from one car to the other.

English railways also do quite a considerable business in horse and carriage traffic. This traffic involves a good deal of trouble, and is apt to cause delay to passenger trains. It is therefore the custom on most lines to decline the carrying of this class of traffic on their best expresses, and in many cases at special seasons of the year when the passenger movement is very heavy. When this is the case it is usual for the companies to run special horse and carriage expresses. These trains, especially on the Anglo-Scottish services, frequently handle a very large amount of business. Our next two pictures show us typical English vehicles for dealing with this traffic. Figure 77 represents a 4-wheeled carriage truck for the London & North Western Railway, and Figure 78 a 4-wheeled horse box for the London, Brighton & South East. The horse box has a groom's compartment at one end, 4 feet 3 inches wide, furnished like an ordinary third-class carriage, and a harness cupboard at the other. The doors of the horse box are made in two sections, the upper section consisting of two swing leaves which move on hinges in the usual way, but the lower and larger part of the door forms a single

hinged ramp. This ramp is hinged at the bottom, and when opened falls outwards so as to provide a passageway for the animals into the box. The interior of the box consists of three stalls which are separated from one another by partitions thickly padded to prevent injury to their occupants. The body of this vehicle measures 18 feet 6 inches long and 7 feet 9 inches wide. In America the horse car, like nearly all other railroad stock, is carried on bogies, and provides accommodation for 16 horses, arranged four abreast. Feed troughs are fitted which can be lowered from the roof when required during long journeys. A recent horse car built for the Lake Shore & Michigan Southern Railway is a 12-wheeled car providing roomy accommodation for 24 animals. It is even built with a clerestory roof like a passenger car.

Beside all these special kinds of traffic there is also in England an immense mass of parcels traffic handled by the companies for which provision is made in the ordinary guards van. In America this class of business is almost entirely in the hands of private companies called express companies. These companies run their own cars specially fitted for the business which they have to handle, paying the railroad company at an agreed rate for haulage, and in their turn charging their customers at their own rates for the parcels entrusted to them. But the American express company is something very much more than a mere parcels carrier. Its operations also include practically all that is undertaken by the British post-office, except telegraph and telephone services. That is to say, the express companies will receive, insure, and be responsible for the safe transit of valuables which you may entrust to their care. They also issue their own cheques, money-orders, and letters of credit.

FIG. 75. BOGIE TRUCK TO WORK ON PASSENGER TRAINS, LONDON AND NORTH-WESTERN RAILWAY.

FIG. 76. HOW LONDON GETS ITS MILK. BOGIE MILK VAN, GREAT WESTERN RAILWAY.

The express company's business on a train is entrusted to their own employée, called the "Express Messenger." He travels in the express car, or if there is not a special car on the train allocated to express business, then in an entirely separate compartment of the baggage car. The express car is not only equipped for the carriage of parcels large and small, and of baggage, but also with a safe in which the express messenger keeps valuables entrusted to his care under lock and key. Some of the express companies also have cars fitted with ice tanks and insulation for the carriage of fruit and other perishable commodities. The American express business was begun 70 years ago in 1839 by William F. Harnden, who conceived the idea of himself travelling as a messenger between New York and Boston. From this little beginning have sprung the widespread operations of the express companies of to-day.

The history of the American express companies is a most romantic one, and it has not infrequently happened that out West trains have been held up by armed robbers for the sake of the treasure carried in the express car, and the express messenger has paid with his life for his fidelity to duty. On many of the American railroads the express business, though nominally performed by a separate company, is really only a branch of the railroad company's operations, just as in the case of the English lines.

When an English railway company is called upon to undertake the transportation of bullion or specie it becomes necessary for them to employ a special bullion van. This van is usually a small 4 or 6-wheeled coach often built of steel and provided with a safe door and lock, like that of a bank. Sometimes there is a passenger compartment forming part of the van in which the repre-

sentatives of the consignors of the treasure may travel. This bullion van is always marshalled next to the engine. In our picture of the Irish Mail crossing Menai Bridge, Figure 69, the first van on the train is an ordinary parcels van such as is used either for the railway company's own parcels traffic, or to accommodate the heavy parcel baskets of the parcels post service. Parcels, not needing to be sorted on the journey as letters are, do not call for the same elaborate equipment as is provided for the letter post.

We have now to consider together a little the duties of the men forming the crew, as the American term is, of passenger trains. As we have already seen in dealing with the luxury of modern passenger travel in Chapter IV., the staff of an American passenger train involves a considerable number of men with very varied duties. We saw there something of the duties of the Pullman conductor and porters. There remain, however, the duties of that important person who is called in America the conductor, and in England usually the guard. The guard or conductor is in general charge of the safety of his train and its passengers. Of course this is so in so far as this safety is not provided for by the even more responsible duties of the locomotive engineer, or engine driver, as he is called in Great Britain. Both in England and America the duties of the chief guard or conductor include the responsibility for seeing that the train is keeping time, or if time be lost, of explaining where, how, and why the bad time-keeping arose. In this connection is involved the filling up of a report or log of every trip which he makes. These reports go into the offices of the divisional superintendents of the line and should enable them to put their finger on any weak spot in the company's administration where for one

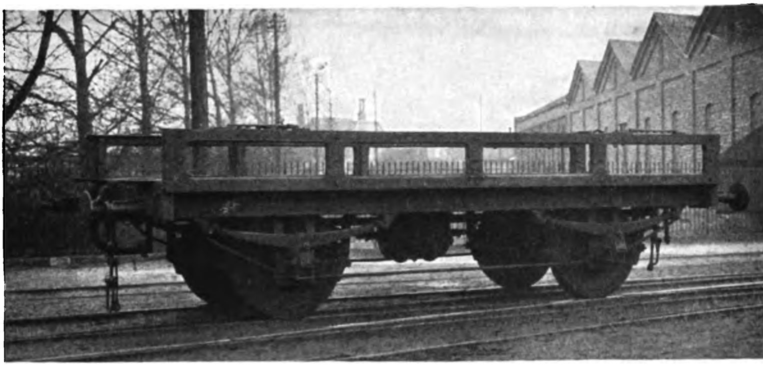

FIG. 77. CARRIAGE TRUCK, LONDON AND NORTH-WESTERN RAILWAY.

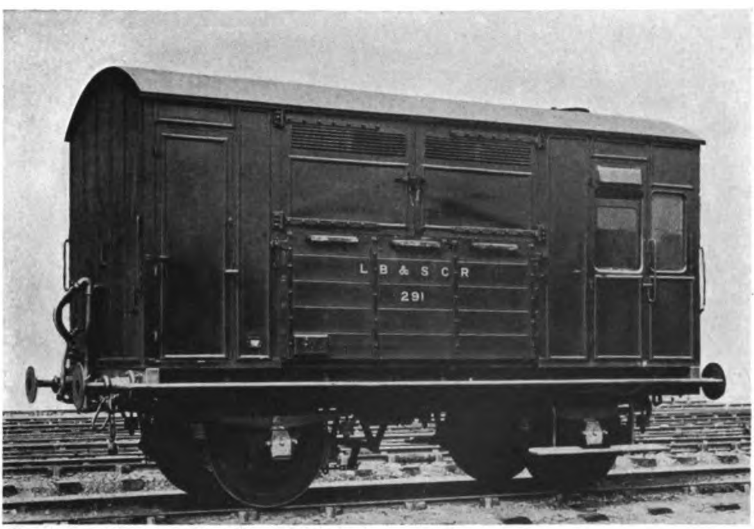

FIG. 78. HORSE BOX, LONDON, BRIGHTON, AND SOUTH COAST RAILWAY.

reason or another the work is not being satisfactorily done.

The guard's duty also includes making a return of all the vehicles on his train, and notifying their number to the engine driver. He must also in a general way attend to the comfort and safety of his passengers. This applies more especially in England to the time while the train is standing at a station. Of course in America and in England in the case of vestibule trains it is possible for a guard to move about his train after it has left the station. All goods and parcels consigned by passenger train are entrusted to the guard's care, and he is responsible for checking them against the entries on the way bills when they are handed over to him, and for seeing that each consignment is safely delivered into the hands of one of the station staff at its destination.

The guard must also see that the continuous brakes of the train are in working order. For this purpose a gauge, either vacuum or Westinghouse, as the case may be, or both where the stock is fitted with both kinds of brakes, is provided in the guard's van. The guard is also in a measure responsible for seeing that all instructions to enginemen as to speed limits and such like precautions are duly observed. If, for instance, he should fancy that in his judgment the train was proceeding at too high a speed at the entrance to a curve, or in running into a station, he would take measures to check the speed by applying the continuous brake through the valve fitted in his compartment.

On most English main line trains two guards at least are carried, in which case the junior guard rides in front, and the senior in the rear van. In this case the junior is responsible for all parcels and their way bills, and the head guard for passengers' luggage and any

railway letters should such happen to be carried on the train. The parcel guard has rather a heavy time of it, especially as Christmas draws near, bringing with it, as it does, unusually heavy consignments of small parcels, and long dark nights in which the way bills, none too clearly written on flimsy paper, and often defaced by lying about in the wet, have to be deciphered as best they may by such light as the roof lamp affords. On many English railways, even those lines which have adopted gas for lighting their passenger stock, the guards' brakes are still lit by the old indistinct oil lamps. It is, however, being more generally recognised now by carriage superintendents that a brilliant light in the guards' van is a real necessity if the work, especially at heavy times, is to be smartly dealt with, and so, for instance, the two splendid specimens of modern British guards' vans which are illustrated in Figures 79 and 80 are lighted by the same method and with the same brilliancy as the ordinary passenger stock of the trains to which they respectively belong. In the case of the East Coast van, Figure 79, the illuminant is Pintsch gas, and in the London & North Western van, Figure 80, Stone's electric light.

Dogs are apt to form a troublesome parcel for a guard to deal with. A kennel is provided for such a parcel to travel in, usually in one corner of the van, but the job of handling a strange animal, which may be ferocious, but for any damage to which the guard will probably be held responsible, is not a very pleasant one. Shelves are fixed for the reception of smaller parcels as far as possible, but at the same time their disentanglement from a stack, which perhaps reaches from floor to roof, is not always an easy matter, and in the case of a hard-working main line train, making fairly frequent

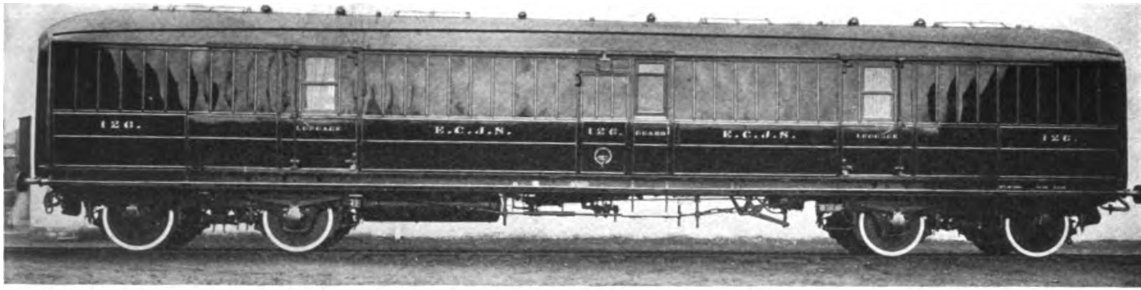

FIG. 79. BAGGAGE CAR EAST COAST JOINT STOCK.

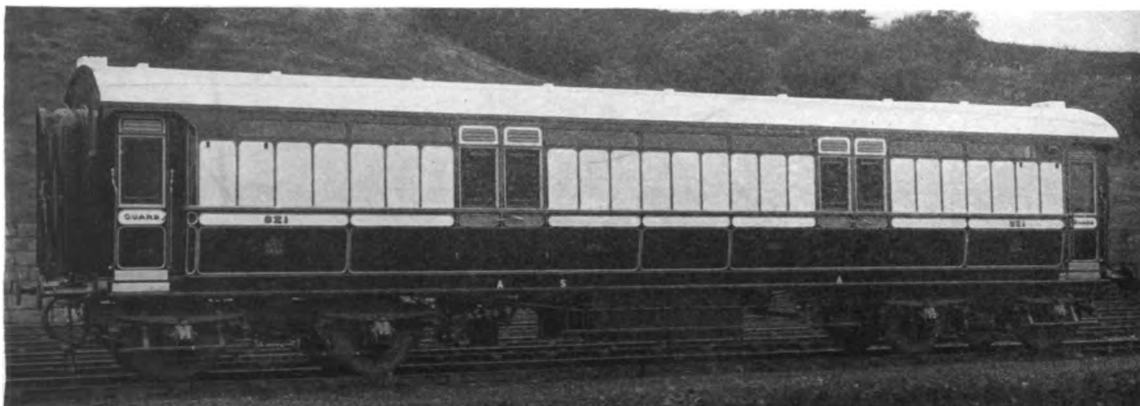

FIG. 80. BAGGAGE CAR, LONDON AND NORTH-WESTERN RAILWAY.

stops, keeps the parcel guard busy during the whole trip.

The American passenger conductor has usually considerably more men under his direction than the English guard. The express agent attends to the parcel business on the train, and in the baggage car there are carried men whose special business it is to attend to the handling of passengers' luggage. In the case of a limited train, as we saw in Chapter IV., one baggage porter usually suffices. In addition to these men there are the sleeping-car porters, and at times also the crew of the dining-car over whom the conductor has a sort of co-ordinate authority with their own chief.

I have said, I think, enough to show that in the normal course of train working the man responsible for the carrying out of the work attaching to a passenger train has an important and arduous position to fill. But true as this is, in the quiet days of normal working the responsibility is increased tenfold in the event of a wreck. It then becomes the guard's duty to take steps for the protection of his train. In England the assistant guard, if there is one on the train, must go back over the line along which the train has come for a certain distance, as provided in the company's regulations, often half a mile or more, and be prepared to flag or otherwise stop any following train. For this purpose guards are always required to carry a supply of not less than 12 detonators as well as their signal flags and hand-lamps. These detonators or fog signals are fastened to the rail by means of the little clips with which they are provided, and are exploded by the first wheel of any train passing over them, thus calling the attention of the engine-driver and guard of that train to the warning given. In England, of course, it is the custom for all trains to be pro-

tected absolutely by the block system, but in America, even now, strict block working is rather the exception than the rule, and the protection of a wrecked train from a following one is a matter involving the greatest care and frequently a considerable element of personal risk to the servant carrying out the duty. In America the conductor would send out a brakeman in either direction in order to protect the train in the event of such an occurrence.

For slight mishaps, such as the breaking of a coupling chain, or parting of a brake hose, guards in England carry spare hooks and shackles and also one or more spare lengths of coupling hose. In the picture of the interior of the London & North Western van, Figure 81, the spare hose for the automatic vacuum brake can be seen secured in clips just inside one of the doors. The hand-wheel in the centre of the van in the same picture provides for braking the wheels of the van itself by hand in case of need. It is becoming more and more the custom in England now to build brake vans of a similar size and contour to the other passenger equipment. In America this has been the rule for many years past, but in Europe generally, as on many English railways until recently, small 4-wheeled vans are frequently used on trains otherwise composed of bogie stock. The two handsome cars for the East Coast Joint Stock, and the London & North Western, respectively, Figures 79 and 80, are good examples of the best British practice in this respect. The East Coast van was built by the Great Northern Railway at their Doncaster shop in 1906. Its extreme length over vestibules is 57 feet 11 inches. The underframe measures 55 feet long. The body measures 8 feet wide, while the width over the guard's wing is 9 feet. A peculiar feature of this fine car is the luggage

Fig. 81. London and North-western Railway, Interior of Guard's Van.

doors, which are arranged to move slightly outward and then to slide along prepared ways so as to allow the maximum possible opening to the doorway. Sliding doors are a standard feature of American baggage-car design, but this instance is almost the only example of the kind used in England. The car weighs 23.75 tons. It is lighted by Pintsch gas and four skylights in the roof are provided for giving light by day. The van for the Great Northern's great rival, the London & North Western, illustrated in Fig. 80, forms part of a train built for the special American boat train services between Euston and Liverpool. It measures 50 feet long and 9 feet wide. No guard's wings are provided and the body can consequently be built out to the full width otherwise occupied by these excrescences. For a vestibule train provision of guard's wings or look-outs certainly does seem unnecessary. This car, like the rest of the splendid train of which it forms a part, is lighted by electricity, and a new and very attractive feature of its design is the provision of long upper panels of glass running the whole length of the car and affording a considerable amount of light by day. The exterior appearance of these vehicles is quite unique in British practice, and as in other recent North Western examples is practically a reproduction of the American vestibuled baggage car. The guard enters by doors at either end opening into the vestibule. The luggage doors are doubled, swinging outwards on hinges in the usual English manner. Each door has a slate panel let into its lower half, upon which directions may, if necessary, be chalked.

Our next picture (Figure 82) shows us a small four-wheeled van for the Hungarian State Railways. We have already seen in Figure 46 an example of the way in

which these little baggage vans are still run in Europe, even on trains otherwise composed of modern bogie stock. On the Hungarian State these vans are practically standard on all ordinary passenger trains. In general outline and design they are not unlike the pattern of guard's van used up till within the last few years by some of the English railways.

As will be seen from the photograph they are provided with a guard's look-out raised about the roof. The luggage doors are of the sliding type, and double, while the guard's door is an ordinary swing door opening outwards, but contrary to British practice in similar vans is at the opposite end of the coach to that at which his look-out is provided. The under-frame is of steel, and the body of the car is covered with a sheeting of thin steel plates. The total length of the van over end sills is 19 feet 8 inches. The bodies are painted dark green, the iron work in black. One of the curious features of railway travel in Europe is the disproportion between the length of the journeys involved and the size of the vehicles employed. In America one feels that the big cars speak of the vast distances to be traversed, and it comes with something of a shock to see standing on Calais Pier a little 4-wheeled parcel or mail van labelled for far distant destinations on the other side of the Alps.

I have already referred, in previous chapters, to the need of warming trains in winter. The old-fashioned hot water tin, or foot-warmer, still survives on British lines, but in most countries, and also on the best English trains now, it has been superseded by some system of continuous heating by steam derived from a generator powerful enough to provide a comfortable temperature to the whole train. The first, and still the most usual means of effecting this provision, was by drawing steam

from the boiler of the locomotive. This steam circulates through the train by means of pipes coupled up between the carriages by hose similar in pattern and appearance to the brake hose. We have already seen in Figure 30 the new Westinghouse device providing an automatic coupler to effect the union of brake and steam heating hose automatically at the instant of impact.

In North America it was, however, soon found that the provision of an adequate supply of heat to comfortably warm the train during the severe winter months involved too great a drain upon the boiler capacity of the locomotive. The device was therefore adopted of providing, at least during the most severe weather, a steam heating tender from which all the warmth required for the train might be drawn. The Chicago, Milwaukee & St. Paul Railway was one of the first to install a tender of this type on their express trains during the winter months. The tender consisted practically of a bogie box car carrying a small locomotive boiler and engine, which latter was utilised for driving a dynamo which should supply light to the train, while the exhaust steam from the boiler supplied the needed heat. And it was found that even the hauling of this additional heavy car involved less strain on the train engine than when its own boiler was being denuded of steam to supply the heating power required. At the time when this type of car was first put into service, too, the problem of train lighting had not yet been satisfactorily solved. The Pintsch gas system was still in its infancy, and no satisfactory plan of providing each car with an independent electric lighting equipment had yet been devised. If electric light was used at all current was provided either from a dynamo worked off one of the axles of the baggage car, or else by a weighty and inconvenient system of storage

batteries carried beneath the floor of the passenger cars themselves. The latter system involved such an increase of dead weight to a heavy train that it was looked upon askance by the railways. The former system as originally applied involved the disadvantage that whenever the train was at a standstill the light went out. The steam heating tender, therefore, was received with additional favour as providing for a continuous supply of lighting current independently of the moving of the train or the presence of a locomotive, and thus enabling the old inadequate oil lamps, which had hitherto been the only alternative, to be superseded.

In Figure 83 we have a picture of a very neat little heating and lighting tender built by Messrs. Ganz & Co. for the Hungarian State Railways. This car is similar in design and principle to the one first devised by the engineers of the Chicago, Milwaukee & St. Paul. It is, however, smaller, running on four wheels only, and measures about 29 feet 7 inches over end sills. The height above rail level is 12 feet 3 inches. The boiler is of the locomotive type with a heating surface of nearly 177 square feet, and a grate area of about 10½ square feet. The working pressure is 150 pounds per square inch, and a coal bunker and water tanks are of course provided on the tender. No engine or dynamo is, however, fitted, and the tender itself, like the rest of the train, is lighted by gas. These steam heating tenders are a part of the usual equipment of express trains in the northern countries of Europe, such as Hungary and Russia, during the winter months. The tender is usually marshalled in the centre of the train, and feeds the cars both fore and aft.

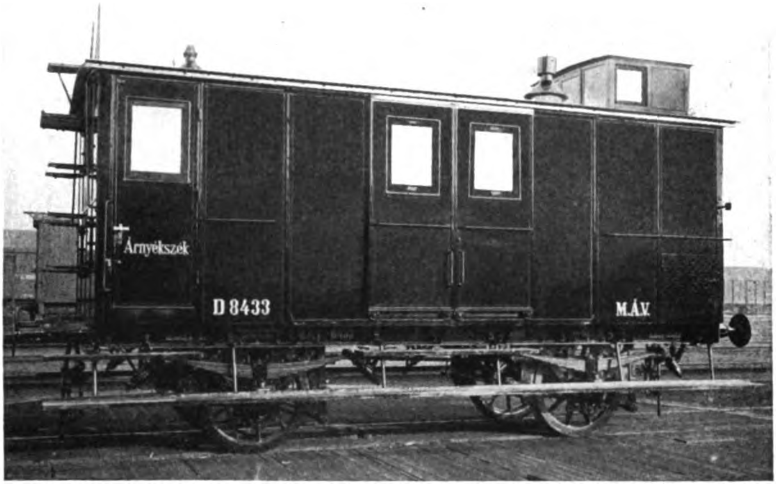

Fig. 82. Four-wheeled Luggage and Guard's Van, Hungarian State Railway.

Fig. 83. Heat and Light Tender, Hungarian State Railway.

PART II—FREIGHT

VIII

Freight Cars

We have now studied together the general principles underlying the design of railway passenger stock, and learned something about the application of those principles in special cases. We have next to turn to the consideration of the same principles and ideas as they are worked out in the design and construction of rolling stock for the goods, or freight, traffic of the road. In many ways this latter division of our subject is, one cannot help feeling, more interesting than that which relates to passenger traffic. Awe-inspiring as the sight of a heavy vestibuled express making her mile in 48 seconds must always be, there is, I think, something even more impressive to the imagination in the sight of freight cars gathered together from over wide tracts of country, and bearing loads representing all the varied activities of human enterprise, being marshalled into the widely varied make-up of a prosaic goods train. Underneath the plain and unornamental exterior of the freight car a thoughtful mind will discern busily at work all the principles upon which the science of railroading is being slowly built up. It is fascinating to stand upon the platform of some great passenger depot watching the busy coming and going of people of every kind, representing all sorts of divergent characters and inter-

ests, and all alike becoming, for a few hours, bound by the common tie of travel into one heterogeneous train load of passengers. But it is even more impressive to stand among the tracks of some huge freight yard and note something of the varied histories lying behind the different consignments gathered, it may be, from half a continent away. All the industry and business of a country is reflected in the tracks of its goods yards. Long trains of coal wagons tell of the hundreds of its workers who spend their lives underground mining the stuff which is to provide the motive power for the machinery by which the country's wealth is to be accumulated. To the railway man also this precious freight has another story to tell. If he sees it loaded in 4-wheeled 8- or 10-ton wagons he knows that he is looking upon a line whose difficulties are revealed to him by that very fact. If, on the other hand, he sees the same kind of freight loaded in great 40- or 50-ton steel cars, he reads in the presence of these cars on its track, the record of a road which has either by favourable situation, or by desperate enterprise, cut itself free from the trammels under which other companies have to work. These huge cars tell him of a coal-shipping plant which is being brought up to the highest stage of efficiency and economy, while the little 4-wheelers tell him of a road which is, for some reason or other, the removal of which would perhaps involve a prohibitive expenditure of resources, compelled to conform to the requirements of modern commerce in the best way that it can. In the same way an American flat car, or English high-sided wagon, groaning beneath the load of fragrant hay, brings the very breath of distant meadows into the grimy atmosphere of a city yard. Tank cars call up before the mind visions of distant oil fields, and gushing oil wells, possibly also of tank steam-

ers crossing stormy seas to discharge their cargoes into the cars which he sees before him.

A Great Northern or North Western train of box cars seen anywhere between London and Bradford, links up the grimy activity of the latter city with the far-off lonely Australian ranges from which the wool with which they are loaded has come. Just so, to the American, an Illinois Central car, let us say, or a Louisville & Nashville loaded with cotton for the spinners of the North connects the noisy looms of New England, or even distant Manchester, with the tropical heat and life and colour of the South. Instances like these of the romance of the goods yard may be multiplied by each reader for himself as he calls up to memory that road or part of a road which he knows best. Whether the goods yard of his thoughts be peopled with cars bearing the products of pleasant farm lands, such as fruit and wheat and milk and stock, or whether they be creaking under the weight of immense castings, or loaded with minerals of some sort dug out from the earth, they all alike have a story to tell to those who will try to look behind the cars and their loads, either to the place of the latter's origin, or to the careful design and cunning workmanship of which the cars themselves are an embodiment. There has been more room for the display of a keenly scientific spirit in the design and construction of freight cars even than is involved in the case of coaches for passenger traffic.

The margin of profit to a railroad is nowadays so slender that it is only by the most careful study of the economics of railway working and the adaptation of results thereby gained in actual car-building that the business of the road can progress satisfactorily. The circumstances of railway working to-day are such that it is upon the skill of the car-builder and the careful

organisation of the car superintendent that the prosperity of the road to a very large extent depends. The conditions, however, under which these officers have been obliged to do their work have varied very much in different countries. In America, owing to a combination of causes, the devolopment of scientific railway working has been almost uninterruptedly possible. The American railroads, for the most part, have a fairly long average haul for each consignment of freight. Their shipping facilities have been considerable and their traffic, in a word, has been what may be described as wholesale. In Great Britain, on the other hand, the railways have been compelled to face their business conditions under the handicap of serious physical difficulties. The result of this has been that the introduction of the large and economical American freight car has not been possible for the most part in Great Britain. As we shall see later on, British railways have taken advantage of improved methods of car construction wherever it is possible, but the most usual type of vehicle still in use to-day for the conveyance of freight in Great Britain is the little 4-wheeled goods wagon. The use of this type of wagon seems to be rather prescribed to English roads by two circumstances, the one physical and the other economic. The physical circumstance lies in the fact that a small wagon of this kind can be readily run into and out of warehouses, to which access can only be gained by means of a small turntable or lift. In many cases also for mineral traffic the use of this type of wagon becomes necessary because coal tips have been built to lift wagons of this size, and as these tips are often not owned by the railway companies, there is frequently a difficulty in obtaining the installation of a new tip which would accommodate a more efficient and economical type of wagon.

The economic difficulty in the way of employment of larger goods wagons in England, lies in the fact that nearly every shipper expects to have a wagon placed at his sole disposal, and worked through to its destination, even when his consignment may be quite a small one, and far below the carrying capacity of even the little wagons actually in use. Manifestly under such circumstances there could be no real gain in economy of working from the introduction of larger wagons.

This little preface to the subject of goods working will help us to understand wherein the difficulty and the interest of the car-builder's work lies as regards this part of his profession.

As in the case of passenger stock, we may begin by just a glance at two specimens of old goods wagons, pictures of which I have been fortunate enough to secure by the kindness of the engineers of the railways into whose hands these relics have now fallen. Figure 84 shows us an old wagon for the Bodmin & Wadebridge Railway, which as we have already seen in Chapter I., now forms part of the London & South Western Company's system. This old wagon is not very dissimilar in shape to the farm wagon which it to some extent displaced, and had a carrying capacity probably not greater. Figure 85 is a little 4-wheeled wagon belonging to the North British Railway. It measures 17 feet in length over buffers, with a wheel base of 7 feet 6 inches and a width of 7 feet 4¾ inches. The height of the sides from the rail level is 7 feet 2½ inches. The wagon weighs 4½ tons and has a carrying capacity of 8 tons. It is provided with both end and side doors, the former being adapted for emptying the wagon of coal at a coal tip. Both this and the Bodmin & Wadebridge wagon are provided with the "old dumb" buf-

fers, which were merely prolongations of the solebars beyond the head-stocks, the end of the bars being bound round with an iron ring, as shown in the picture, to prevent their splitting under the frequent impacts.

Many accidents have occurred in shunting yards attributable to the use of these buffers, and a great deal of money has been wasted in repairing damage caused by shunting these old solid buffered wagons in trains containing wagons of cars fitted with spring buffers, and it is a great satisfaction to all connected with railway working, other than the owners of such wagons, to be able to record that the first of January, 1910, is the date fixed for the final abolition of these barbarous relics from English railways.

The principles of construction which we have already studied in considering the building of passenger cars are identical with those governing the construction of cars for freight service. The application of these principles is necessarily a little different, owing to the different conditions of the service; thus, for instance, it is necessary, especially in open coal cars, to provide against the bursting of the wagon sides by the loads carried. As any system of cross-bracing in an ordinary open car is practically out of the question, this can only be effected by making the stakes, as they are called in America, or stanchions, as the English wagon-builder terms them, of sufficient strength to withstand the thrust of any possible load which may be imposed on the wagon.

On the other hand, in the box car no space need usually be left for windows, and the side bracing of the walls may therefore be continuous from floor to roof. As a set-off against this there is to be reckoned a need for a wide doorway being cut in the centre of the body frame. The carlines or roof sticks, as they are called

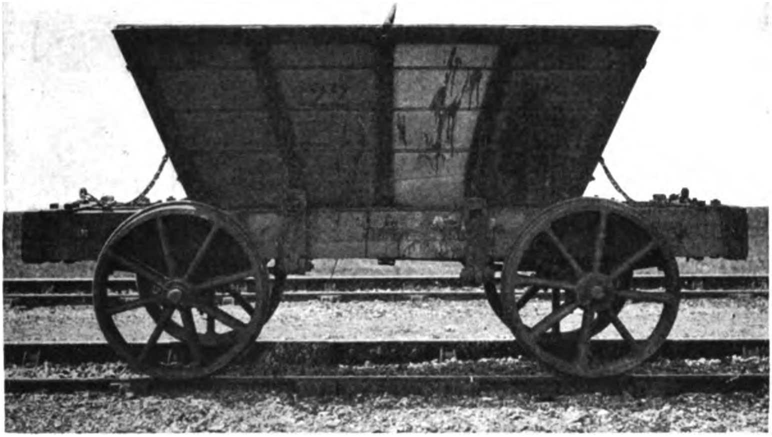

FIG. 84. HOW A FARM CART WAS MOUNTED ON RAILWAY WHEELS. EARLY GOODS WAGON, BODMIN AND WADEBRIDGE RAILWAY.

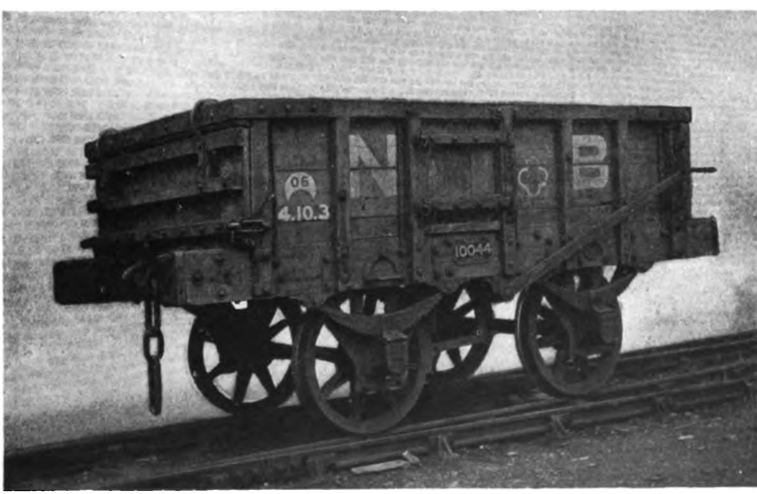

FIG. 85. OLD COAL WAGON, NORTH BRITISH RAILWAY.

in England, may also be used, if necessary, to tie the sides together in some degree. The box car is by far the most usual type of goods wagon used in America. It is also a favourite type in all countries for use with any freight that is of a perishable nature. The roof of course obviates the need for sheeting or other protection for the load. Beyond the difference in size, box cars in England and America are all built upon pretty much the same lines. Figure 86 gives a good idea of the style of framing adopted for the bodies of cars of this type; it shows the freight-car erecting shop in the Canadian Pacific Railway's Angus works at Montreal. These large box cars are, of course, always carried on two 4-wheeled bogies, whereas the English and European railways generally use box cars of the 4-wheeled type.

Box cars are still usually built of wood, though in England steel under-frames are frequently used. American builders often employ Norway pine for the sills and floors of their box cars. This wood is found to be extremely suitable for this purpose when dry, but exhibits a tendency to rapid decay when exposed to the weather, especially when the sap wood is used. In building freight cars the cost of construction is an important item. Builders therefore frequently lay the floors with simple overlap edges instead of the tongued and grooved work necessary for passenger cars. Floor planks are usually 1¾ inches thick. The side-plates, or longitudinal beams, resting on the top of the posts of the car body, are usually made of pine, the rest of the car being built of white oak.

When the pull of a locomotive is applied to a heavy freight train there is apt to be set up a serious strain in the bodies of the cars composing the train. The power

required to propel the train is applied to the front drawbar of the first car. This drawbar transmits the strain through the framing to the rear drawbar of the same car, and so the pull goes through the train. The effect of this is that the strain endured by any car varies according to its place in the train, and if near the head of the train imposes a good deal of distress on the under-frame and drawgear of the car. To avoid this the plan has been suggested of employing a continuous drawbar extending from one end of the car to the other, but this has not been found to be altogether successful in practice, because the drawbar, if continuous, is very apt to be broken in buffing, and should this break take place, as it usually will do, underneath the car body, it involves rather heavy repairs. Relief is therefore sought rather by the introduction of some form of friction draft gear. The general principle underlying this kind of gear is the introduction of springs to mitigate the strain of the direct pull on the car framing.

The body frame of a box car is covered with dressed and matched boards. A curious little divergence of practice appears on comparison of English and American box car exteriors. The outside match-boarding of an American car is placed outside the body frame, and the tongued and grooved boards are laid vertically. This may be seen by reference to a box car for the Missouri, Oklahoma & Gulf Railroad in Figure 106. The English practice on the other hand is to clothe the sides of their box cars by boards laid horizontally and inside the frames. Some idea of this may be gained by the picture of a fruit van, which is only a modified box car, for the Great Northern Railway in Figure 124. These side planks are usually from $\frac{3}{4}$ inch to $\frac{7}{8}$ inch thick and in

FIG. 86. BUILDING FREIGHT CARS, ANGUS SHOPS, MONTREAL, CANADIAN PACIFIC RAILWAY.

American cars are nearly always beaded on the outside by way of ornamentation.

The roof is a most important part of the structure of a box car. On its efficiency depends the protection of the load from snow or rain, and any attempt to save expense in construction at the cost of weather-proofness will inevitably result in the owner of the car being faced sooner or later with heavy claims for damages. As might be expected, many different devices have been proposed to secure a cheap and yet perfectly weather-proof roof. They are built either of double boards, one layer placed so that the lines between the boards come across the lines between the boards of the other layer, either at right angles, or at about half a right angle; or of a single layer of boards, either lined or covered with tin or other sheet metal. Other linings that have been proposed have consisted either of some form of paper, or composition, covered with the roof proper of tongued and grooved boards. In the large 40-ton box car built by the Leeds Forge Company, Ltd., for the Great Indian Peninsula, illustrated in Figure 105, the roof is made of corrugated iron. Besides the materials of which the roof is to be built, the design itself of the roof is also an important factor. It is obvious that if the roof be made flat there is much more likelihood of water lodging on it, especially between the interstices of the boards, than if the roof be built curved to a larger or smaller radius. Precisely the same principle is involved in constructing the roof of a box car as arranging a roof of an ordinary house. A certain amount of pitch, as it is technically termed, is practically a necessity, and the steeper the pitch, the less chance there is of water or snow lodging on the roof, and therefore the better is the roof. It

would seem necessary, then, to build roofs of which the centre line would form, when seen in section, the apex of a triangle. But here the car-builder is met by the difficulty that in such a method of construction there would be considerable waste of more or less available carrying space, and also by the further practical difficulty that it would be impossible for trainmen to go upon the roof when necessity should arise. As most of my readers will be aware, until within recent years in America at least, there was continual necessity for the brakemen of freight trains to ride on the roofs for more or less of the trip. The need for this dangerous practice is now being rapidly superseded by the introduction of continuous brakes which obviate the necessity for the hand-braking of individual cars. So long as it lasted, however, this practice necessitated not only a modification of the pitched roof, but also the provision of flat boards at the centre of the roof, called "running-boards," along which the brakemen might pass from one car to another. The picture already referred to of the Missouri, Oklahoma & Gulf car, Figure 106, as well as that of the stock car for the Chihuahua & Pacific Railroad in Figure 107, shows these running-boards in position.

The Master Car Builders' standard practice for running-boards is that they shall have a total width of not less than 18 inches. This is usually afforded by 3 strips each 6 inches wide and 1 inch thick of hard white pine. The boards are made to project beyond each end of the car body, a distance of 5½ inches, and these projecting ends are supported on brackets. To provide access to the roofs, vertical ladders are provided at the end of each car near the left-hand corner. Many roads place the ladders at the side of the car near the end, the Chihuahua & Pacific stock car, Figure 107, showing very

clearly one of these ladders in position at the side. The ladder consists of two stout iron uprights bolted to the side sill and to the side plate (in the case of an end ladder the attachment would be of course to the end sill and the end plate), and projecting 3½ inches from the face of the car body. To these uprights, five round iron bars 20 inches long and ⅝ inches in diameter are secured, while a small iron step is also provided projecting 8 inches below the car sills. A grab iron is attached to the roof at the top of the ladder, and the brake wheel is fixed in position near the corner of the car to which the ladder is attached. The brake wheel is raised 2 feet above the level of the roof and may be seen in position in the picture. A clearer view of the braking apparatus may be seen in Figure 100, which represents a flat car for the New York, Ontario & Western Railway, or in Figure 101, which represents a low-sided car for the Lagos Government Railway.

The box car became, from a very early date, practically the standard means of conveyance for freight in America, but in England most of the goods traffic is still carried in the ordinary high-sided wagons. The Americans box car provides safety against weather and also against theft, as it may always be padlocked if necessary. In England, special classes of freight are also frequently conveyed in box cars, as I have already said. The English wagon, usually high-sided, often low-sided, is always carried on 4 wheels. An idea of a low-sided wagon may be gained from the picture of a Lagos Government wagon of this type in Figure 101 which, however, differs from the ordinary English wagon in being mounted on bogies. In Figure 87 we have a picture of a 4-wheeled high-sided wagon for the Hungarian State Railways. This differs from the English 4-wheeled wagon

in being considerably longer over all, and also in having the excrescence, frequently met with in European practice, of a brakeman's box at one end. It is customary for goods trains to be made up with a certain minimum number of wagons or box cars fitted with this slender protection for brakemen according to the severity of the grades which they have to encounter. The wagon in our picture was built by Messrs. Ganz & Co., of Budapest. It is built with steel frame and stanchions and wooden sides. It, is longer than the ordinary English open wagon, roughly speaking, by the amount of the overhang at either end. It may be of interest to record that the initials of the owning road, M. A. V., stand for Maygar Kiralyi-Allam Vasutak. This wagon measure 30 feet 4 inches over buffers, and 26 feet 3 inches long over the body, while the width is 8 feet 3 inches. The overhang of the wagon at the end which carries the brakeman's box is slightly less than that at the other end, in order that the weight on the axles may be equal. The top of the brake box reaches 13 feet 5 inches above rail level.

Figure 88 represents a large 4-wheeled wagon built by Messrs. R. Y. Pickering & Co. to the designs of Sir John Wolff Barry and partners for the Shanghai & Nanking Railway. This wagon has solid cast-iron wheels 2 feet 9 inches in diameter and the body is built of steel throughout. It is carried, like the Hungarian State wagon just described, on laminated springs, and is fitted with an either-side hand brake as well as the Westinghouse automatic brake. The sides of the wagon are 4 feet deep and the inside length is 17 feet $11\frac{5}{8}$ inches, the inside width 8 feet $11\frac{5}{8}$ inches. It is designed to carry about 24 tons of coal on a tare weight of 8 tons 7 hundredweight. The equipment includes automatic couplers, and central buffers of a peculiar design of which

FIG. 87. FOUR-WHEELED OPEN WAGON WITH BRAKEMAN'S BOX, HUNGARIAN STATE RAILWAY.

FIG. 88. A CHINESE COAL CAR.

our picture just gives a hint, and drop-doors of the pattern adopted on most English railways.

The type of bogie used under freight cars presents some differences from those used in passenger stock. In Great Britain the use of the bogie in freight service is confined almost entirely at present to cars for the carriage of coal ore from mine to tidewater. A certain number of bogie wagons are also in use for general shipping business, it being frequently possible to load large box cars of this type fully to and from the ship's side in the docks. But in whatever kind of service used, the principles involved in the construction of the freight car truck are the same, that is to say, strength, cheapness, and lightness. Of necessity these cars are subject to a good deal of rough handling and so their design, and the design of the truck which are placed under them, must have due regard to the important item of repairs. Consistently with due strength it is of importance also to keep down the weight of cars and their bogies, in order to reduce the dead weight or non-paying load to be hauled.

As the bogie for freight service is distinctly an American feature we will begin with the consideration of a bogie of American type. The standard pattern of truck for freight service in America is that known as the "diamond frame" truck, from its shape. Several of the cars illustrated in this and the following chapter present us with examples of diamond frame trucks. The cars for the Missouri, Oklahoma & Gulf, Figure 106, and the Chihuahua & Pacific, Figure 107, the flat car for the New York, Ontario & Western, Figure 100, and the open car for the Rosario & Puerto Belgrano, Figure 102, all show us diamond frame trucks of various builds. If we take any one of these trucks we shall find that they

consist of three longitudinal members, the uppermost of which is called the arch bar, the second member the inverted arch bar, and the lowest the pedestal tie bar. The inverted arch bar requires perhaps a little explanation; in appearance it forms very nearly a diagonal to what may be roughly called the rectangle formed by the arch bar and pedestal tie bar. These diagonals may be seen leading from the top of the pedestal or axle guard, as it is called in Great Britain, of one wheel passing underneath the bolster springs, and up again to the top of the pedestal of the second wheel of the truck. It is this arrangement of bars which has given to this pattern of truck its distinctive name.

The load carried by the bogie rests, through the medium of the bolster springs, directly on the inverted arch bar, which is thus subjected to a strain tending to tear it in half. This form of strain is known as a tensile strain in the technical language of engineers. The resistance of the inverted arch bar to this strain is reinforced by the arch bar, the two bars being coupled together by stout bolts where they meet at the top of the pedestals or axle guards. The strain on this topmost bar, the arch bar, is compressive and the natural result of the two strains resisted by these two bars so coupled together would be that they should bend at the points where they meet. This is prevented by the tie bar which completes the frame by holding the lower edges of the axle guards in place. The size of the various members of the truck depends of course upon the service and capacity of car which the truck is designed to carry. The wheels, however, are usually now standardised at 2 feet 9 inches in diameter and the wheel base of the bogie varies from 5 feet to 5 feet 6 inches. The diamond frame trucks for the Great Indian Peninsula 40-ton box car

illustrated in Figure 105 has wheels of the spoked pattern 3 feet 7 inches in diameter.

The next pattern of truck which we will consider is one which has been put into service in cars built by the Leeds Forge Company of pressed steel under Fox's patents. Bogies belonging to this general class, but of two rather different types, are illustrated in Figure 101, which represents a low-sided car for the Lagos Government Railway, and in Figure 97, which represents a large 40-ton hopper for the North Eastern Railway.

The Lagos Government car has helical springs as in the case of the American diamond truck. Another similarity of construction is in the use of the solid disc wheels. This latter point, however, is not really essential to the type of truck. The helical springs in Fox's bogie are arranged one over either axle box, the pedestals bearing in each case directly on the springs. The rivetted bar work of the open diamond framed truck is replaced in these cars by flanged steel plates. The springs are considerably stiffer than those used on passenger car trucks, and usually are arranged with a deflection of not more than ¼ inch under a load of 3 tons. Easy riding is not so much a consideration in the case of a freight car as the desirability of minimising the fluctuations in height, and the swaying movement of cars under widely varying loads. For this reason both the patterns of bogie illustrated are provided with only one set of springs. My readers will be able to contrast this with the elaborate arrangement of double or triple springs used for passenger car bogies. The truck used under the Lagos Government Railway car is of the open-end type. The one carrying the large North Eastern coal car has, however, closed ends, and the usual English laminated springs. The solebars of the bogie are curved upwards

at the wheel centres to obtain a sufficiently strong bearing at the part enduring the greatest stress. As these upward curving portions of the bogie frame extend to above the lowest level of the solebars of the car itself, it is necessary that these latter should be spaced sufficiently far apart that the free movement of the bogie may not be interfered with. The laminated springs have a deflection of ½ inch per ton of load. The great advantage of this type of bogie is the simplicity of its construction, the fewness of the parts of which it is composed, and also the fact that the rivets used in building it are all of the same size.

A third type of bogie is illustrated in Figure 96, which represents a hopper belonging to the Société de la Providence, and working on the Eastern Railway of France. This bogie also has laminated springs, as in the English type, but the frame is of the built-up pattern adopted by the Baume-Marpent Company, the builders.

The patterns of bogie illustrated will, I think, give us a fair idea of the types in general use. The variations of these types introduced by American builders especially, total up to a considerable number; in particular, the diamond arch bar truck is more or less combined with the pressed steel pattern; but the examples illustrated in this volume, at which we have been looking, will afford us a fair idea of what modern practice in this respect is.

IX

Coal and Ore Cars

The question of the economical working of freight traffic depends on the car or wagon department quite as much as on the locomotive superintendent. It rests with the latter to provide engines which shall be capable of moving trains efficiently and economically, without the undue use of helping or banking engines. But it rests with the car-builder quite as much, to provide cars or wagons which will be economical in the proportion of paying load to dead weight, and also, what is a scarcely less urgent matter, economical in their use of siding space. American engineers have enjoyed a remarkably free hand in dealing with these conditions as I have already hinted. Some of the results of recent development in this direction will come before us in this chapter. English railways on the other hand have found themselves confronted with very considerable difficulties in the introduction of newer and more economical types of goods stock. Figure 89 shows us a new 20-ton steel coal wagon built for the London & North Western. This wagon has a dead weight of 8 tons 1 hundredweight, the paying load being thus 2.48 times the tare weight. This ratio shows a marked improvement over the old English 8- or 10-ton wagon with a tare weight of as much as from 6 to 7 tons. This improved result has largely been brought about by the use of steel throughout in the place of wood.

The London & North Western are bringing these wagons into extensive use wherever possible. The one in

our picture is destined for the use of the locomotive department, and is employed in carrying coal between the pit's mouth and the various locomotive depots, but unexpected difficulties seem to attend the introduction of cars of this type for the use of private traders. It often happens that a coal merchant will order his coal in small lots, especially if he be a dealer in some little country town, with a comparatively small business. Hence it is not always possible for the railway companies to induce the collieries to ship in quantities suitable for large capacity wagons, especially when there is anything in the nature of competition between the railways serving the district.

With regard to the proportion between dead weight and paying load, these 20-ton wagons compare very favourably with recent American practice. For example, a large hopper car to carry 50 tons, American, for the Pennsylvania Lines has a dead weight of 17.15 tons English. The ratio between tare and load is thus 2.59, a figure better than the North Western ratio by about 5 per cent. But although this does not seem a large discrepancy, yet when we come to a consideration of moving coal or other minerals in large quantities, this 5 per cent. may make all the difference between working at a profit and incurring a loss. In instituting comparisons between English and American results, the difference between the English and American ton must not be lost sight of. The English ton weighs 2240 pounds, while the American, or short ton, weighs 2000 pounds. We may try to set out a comparison between English and American rolling stock efficiency, by the consideration of a hypothetical shipment of 1800 short tons of coal. Such a shipment can be actually seen represented in Figure 92 travelling over the main line of the Baltimore & Ohio Railroad

FIG. 89.

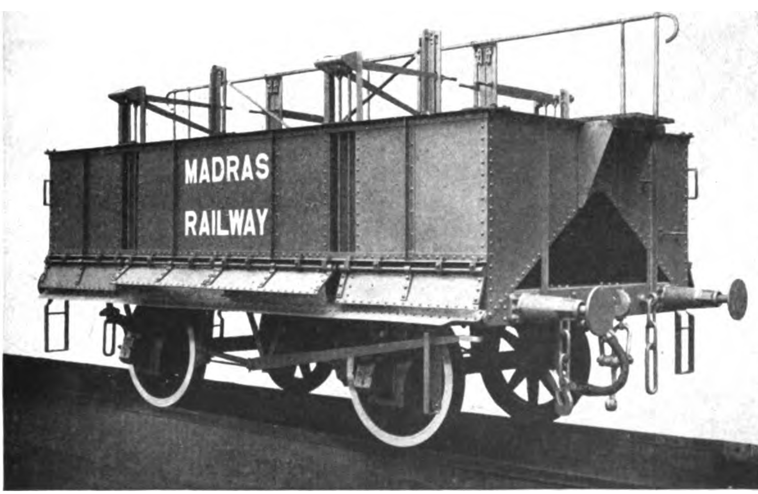

FIG. 90.

STEEL COAL WAGONS.

FIG. 89. 20-TON WAGON, LONDON AND NORTH-WESTERN RAILWAY.
FIG. 90. HOPPER, MADRAS RAILWAY.

along the Potomac valley. In order to make the comparison as complete and extreme as possible I am taking, however, the figures for some new steel hoppers which have recently been put into service on the Wheeling & Lake Erie Railroad, which weigh 16 tons 4 hundredweight, the ratio between tare and paying load being increased to 2.61. To haul 1800 tons in cars of this description would require 36 cars just as there are in the picture, Figure 92. The total dead weight of these cars empty will be 615.85 tons, English.

Now 1800 short tons equal almost exactly 1607 tons English, but in order to avoid the unfairness of providing an extra wagon for the odd 7 tons, we will take 1600 English tons as the equivalent weight to be moved. This would require a train of eighty 20-ton wagons such as that in Figure 90, the tare weight of this train being 647 tons. The weight empty of the English train again shows an increase of about 5 per cent. The most serious objection to the English train, however, is to be taken on the score of length, which works out at 1960 feet as against 1134 feet for the American train, an increase of nearly 75 per cent. But the case is really even worse than these figures would suggest. To move this 1600 tons of coal would require on all British lines two trains at least instead of one, and there would thus fall to be included the length of an extra engine and guard's brake. Another important point which ought not to be lost sight of in the comparison is, that as things stand at present, while the American train is under perfect control by means of the Westinghouse quick-acting brake, the English train is under very partial control, the only braking power being the steam-brake on engine and tender and the hand brake in as many guards' vans as were included in the make-up of the train. While, therefore, it seems

clear that in regard to dead-weight capacity English engineers, during the last few years, have made strides which are really wonderful considering the difficulties under which they are labouring, there is yet a great deal to be done in reducing the length of trains, and in improving the control which a driver has over his train, thereby enabling higher booked speeds to come into force for this class of traffic. I need not, I think, stay to point out the immense effect which these two factors have on the carrying capacity, and therefore on the earning power, of any given railway.

The difference between working conditions in the two countries we may realise pictorially by a comparison of Figure 91, which shows us a Great Northern coal train leaving Doncaster, with Figure 92, which represents, as I have already said, a scene on the Baltimore & Ohio line. The Great Northern train consists of thirty-one 20-ton coal wagons, and is carrying 620 tons English, or 694.4 tons American. The Baltimore & Ohio train, as we have just now seen, consists of 36 cars. The difference between the locomotives at the head of the two trains is also interesting. The Great Northern engine is of the 0-8-0 type with 4 feet 8-inch drivers, a pair of simple cylinders, inside, measuring 19¾ inches by 26 inches and a boiler affording 1440 square feet of heating surface, with a working pressure of 175 pounds. The Baltimore & Ohio engine, on the other hand, is of the 0-6-6-0 type with 4 feet 8-inch drivers. It is in fact the huge Mallet articulated compound, the first of its kind in the United States, but which is now coming into fairly extended use in various parts of the world for heavy traffic. The high-pressure cylinders are 20 inches in diameter with a 32-inch stroke, and drive the rear group of coupled wheels. The low-pressure cylinders

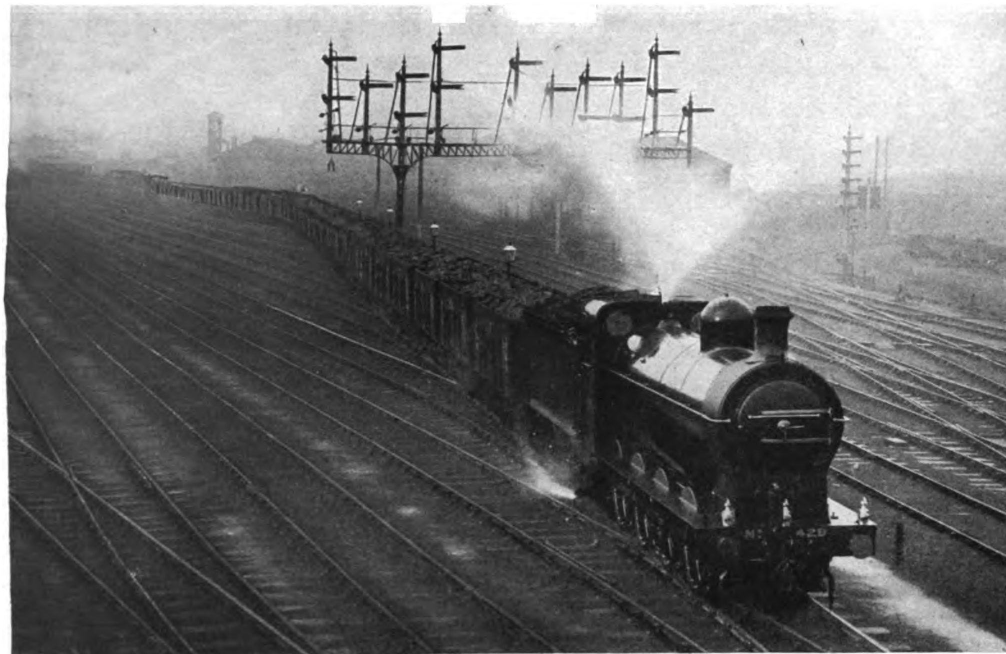

Fig. 91. Coal Train leaving Doncaster, Great Northern Railway.

are attached, not to the main frames of the engine, but to the frame of the leading bogie, and drive the foremost group of coupled wheels. They measure 32 inches in diameter with a 32-inch stroke. The boiler is no less than 7 feet 4 inches in mean diameter, and 21 feet long. It furnishes 5585 square feet of heating surface and carries a working pressure of 235 pounds. The engine alone weighs a little over 149 tons 7 hundredweight. As our picture shows us this enormous engine is used in taking freight trains across the mountains. In the picture, No. 2400 is shown as a train engine, but much of its work as a matter of fact is in helping freight trains over heavy grades. Previously to the advent of this large compound three heavy consolidation engines were required to take a train over the grade which, for 15 miles out of Connellsville, is against east-bound trains. As a train engine this locomotive has handled trains weighing up to 1975 tons English behind the tender, over grades sometimes as steep as 1 in 100, and being helped only over one bad place where there is a grade of 1 in 100 for 6½ miles on end, and then by one consolidation pusher instead of the usual two.

The expeditious emptying of a coal or ore car is a matter of considerable importance. In England coal is most frequently loaded on shipboard in modern dock installations, by means of coal tips. These tips are arranged to take up an ordinary English 4-wheeled wagon and discharge the load by tilting the wagon bodily either sideways or endways, usually the latter. In wagons destined for this service the whole of the end is arranged as a door swinging from the top, and secured at the bottom by a latch which can be released as the tip lifts the wagon up. Another method of automatic discharge is by the use of what are called "hopper wagons." For this

type of wagon an unloading stage is built up on to which the car is pushed by a locomotive or hauled by a steam or electric capstan. Arrived there, the discharge valves, or doors, of the hoppers may be opened either singly or in combination, as desired, by manipulating the levers which work them. The hopper method is almost compulsory with heavy bogie cars, and in all new docks would certainly seem to be considerably cheaper to install than the expensive machinery required for a coal tip. Figure 90 shows us a 4-wheeled hopper for the Madras Railway. This car was built by the Leeds Forge Company, Ltd., and is designed specially for the conveyance and distribution of ballast. It measures 18 feet over head stocks and 22 feet 2 inches over buffers, the width over all being 10 feet. The height of the hand-rails in the centre of the wagon, from rail level, is 10 feet 9 inches. The tare weight of the wagon is a little over 9.1 tons. The mode of supporting the projecting ends of the running board on backets, to which I have already referred in Chapter VIII., may be seen from this picture. The levers for operating the hopper doors are shown in position at the level of the hand-rail above the running-board. They are so arranged that the load of the wagon may be discharged on either side, and from as many doors as may be required. The main line of the Madras Railway runs across the narrow southern part of the peninsula of India from Madras, on the east coast, to Calicut, on the west, whence the line turns northward along the Malabar coast to Cannanore and Mangalore. Another line branching off at Arkonam, 42 miles west of Madras, runs in a general north-westerly direction to Raichur and, by a junction with the Great Indian Peninsula at this point, forms a through route between Madras and Bombay.

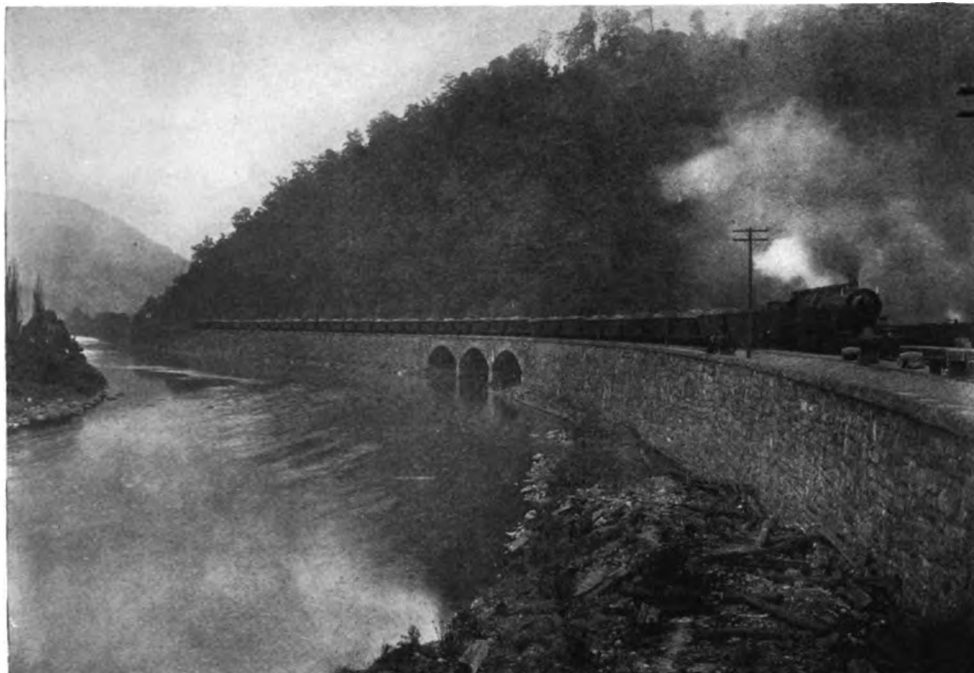

Fig. 92. How Coal is handled in America 1800-ton Train on the Baltimore and Ohio.

Before the introduction of the hopper car into America the bulk of the American coal traffic was carried in what are known as gondolas. Figure 93 shows a car of this type for the New York, Ontario & Western Railway. Originally the gondola was practically equivalent to an English high-sided open wagon. Gradually it grew in length and became a bogie car, and in this form is adapted for the transportation of any kind of freight in bulk which cannot take harm from exposure to the weather. Early gondolas were of wood; the one in our illustration, however, is a modern steel car, with a carrying capacity of 80,000 pounds, a length over end sills of 34 feet and an over-all width of 9 feet 4 inches. Like the English open wagon, gondolas are built sometimes with high sides and sometimes with low sides. Sometimes, too, they are built with drop-ends to enable them to be used for loading lumber. Modern gondolas, when intended for coal traffic especially, have been usually built with some kind of self-emptying bottom door. With this special feature the gondola begins to pass into the hopper. The latter may be defined as a car fitted with inclined floors instead of flat, and self-emptying by reason of these floors and the drop doors. Figure 94 shows us a gondola built by the Leeds Forge Company for the Natal Government Railway under the Sheffield-Twinberrow Patents. Whereas the American gondola, however, is not usually fitted with side doors, this South African car has double side doors very much the same as an English high-sided wagon. This car is for the standard South African gauge of 3 feet 6 inches. It measures 38 feet 8 inches long over couplers, with an extreme width of 7 feet 10 inches. The sides reach to a height of 8 feet from rail level. The wheels are spoked and 2 feet 9 inches in diameter. The tare weight of the wagon is

15 tons 4 hundredweight and the load which it is designed to carry amounts to 35 tons, the ratio between the weights being 2.3. This wagon affords evidence that the rolling stock of the Natal Government Railway is being brought into line with the high standard now obtaining on the other South African lines, some instances of which we have already seen in the passenger department.

Our next picture, Figure 95, shows a hopper car built by the Barney & Smith Car Company, of Dayton, for the Cleveland, Cincinnati, Chicago & St. Louis Railroad, otherwise known as the "Big Four." This car has a length of 40 feet, a capacity of 50 American tons, and a weight of 21.3, a proportion of paying load to tare weight of 2.11. Figure 96 shows an ore car of slightly different design for the Société de la Providence and running on the Eastern Railway of France. The body of this car measures 40 feet 2½ inches in length and a trifle over 8 feet 10 inches in width over all. It has a dead weight of 18 tons 16 hundredweight, and is constructed to carry a load of roughly 40 tons (40,000 kilograms).

The discharging doors of this car are not underneath, but, as will be seen from the picture, the lower half of the sides are hinged to swing outwards when released. The releasing gear for operating the triggers which hold the doors may be seen by the brakeman's box at one end of the car. A kind of screw coupling is employed, and the bogies follow rather an English pattern with laminated springs. This private owner's car was built by the Baume-Marpent Company, of Haine St. Pierre, Belgium. Figure 97 is a picture of a large new car built by the Leeds Forge Company for the North Eastern Railway. The North Eastern has been foremost among English railways in the adoption of the most approved

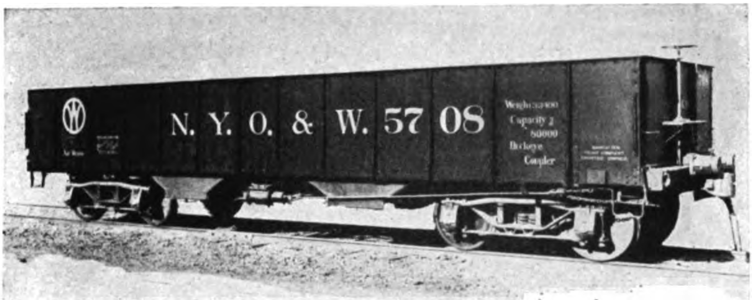

Fig. 93.

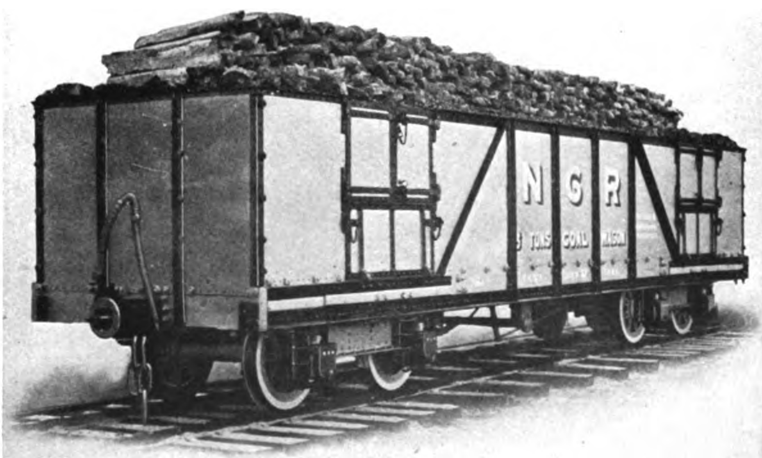

Fig. 94.

Modern Coal Cars.

Fig. 93. Steel Gondola for the New York, Ontario and Western Railway.

Fig. 94. Sheffield Twinberrow Wagon for the Natal Government Railway, with Test Load of Pig Iron.

modern material and methods of operating. Only a few years ago its chief officers made a special trip to America in order to study all that was being done there at first hand, and nowhere in Great Britain can you find a road more deeply impregnated with American methods than the North Eastern. This line has also been fortunate in having perhaps a rather freer hand in putting American methods to the test than has been the case with some of the other large English companies. Although most of their coal and ore traffic has a remarkably short haul, yet on the other hand, the docks and coal tips are largely owned by the railway company and also they have among their customers a great many large engineering works who can take coal and other material in such quantities that the adoption of economic methods of transport becomes readily possible. Accordingly we find, that on the North Eastern, more perhaps than on any other English railway, there has been a marked development in the use of high capacity wagons and cars. The subject of our picture is a magnificent specimen of steel car-building, with a carrying capacity of 40 tons on a dead weight of 16 tons 3 hundredweight, both these measurements being English. The total length of the car, over buffers, is 39 feet, the car body over end sills measuring 36 feet. The width over all is 7 feet 11⅞ inches and the sides reach to a height of exactly 10 feet from rail level. The pattern of bogie employed we have already discussed in Chapter VIII. I need only therefore say here, for the sake of completeness, that each bogie has a wheel base of 5 feet and spoked wheels of 2 feet 9 inches in diameter. The hand brakes on these cars are applied by means of a wheel fitted on either side instead of the usual English pattern lever and quadrant. Our picture shows the car loaded with 40 tons of coal with an

additional test load of 60 tons of pig iron placed on top, or 100 tons in all. These cars have all successfully undergone this test before being placed in service. The initials N. D. placed on either side of the car number denote that the car is assigned to the Northern division of the road, the headquarters of which is at Newcastle-on-Tyne.

Convenient as is the hopper car in the method of its operation, there is yet one other development of the ore car which reaches an even higher level of economy in working. This is what is known as the "dump" car of one sort or another. In Figure 98 we have an illustration of one of the most perfect and elaborate cars of this type yet put into service. This is the Goodwin Dump Car and is adapted to the speedy and economic handling of all kinds of dumpable materials. These cars are daily carrying among other things, stuff such as granite, mud, gravel, clay, broken stone, ore of various kinds, coal and coke. They are used very largely in America by contractors and railroad builders, but also seem to be quite adapted to the ordinary business of a transportation company. They have a high ratio of carrying capacity to dead weight, a car weighing 20 short tons having a carrying capacity of 50 tons. The car in our picture has a length of 36 feet over all, while the car body, inside of the end bulkheads, measures 32 feet 4 inches with a width over all of 9 feet 8 inches. The top of the side girder reaches a distance of 10 feet 6 inches from the rail level. In shape a cross-section of these cars presents the appearance of a large letter X turned on its side. The discharging valves of these cars are so fitted that the load may be dumped on either side of the car outside the track, or on either side of the car inside the track between its own wheels, or, of course, in any possi-

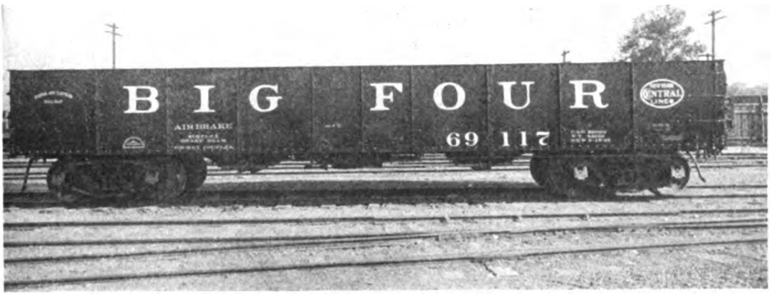

Fig. 95.

Fig. 96.

Bogies for Heavy Freight Service.

Fig. 95. Gondola with Diamond Trucks, Cleveland Cincinnati, Chicago and St. Louis Railroad.

Fig. 96. Dump Car with Closed-in Trucks, for Service on the Eastern Railway of France.

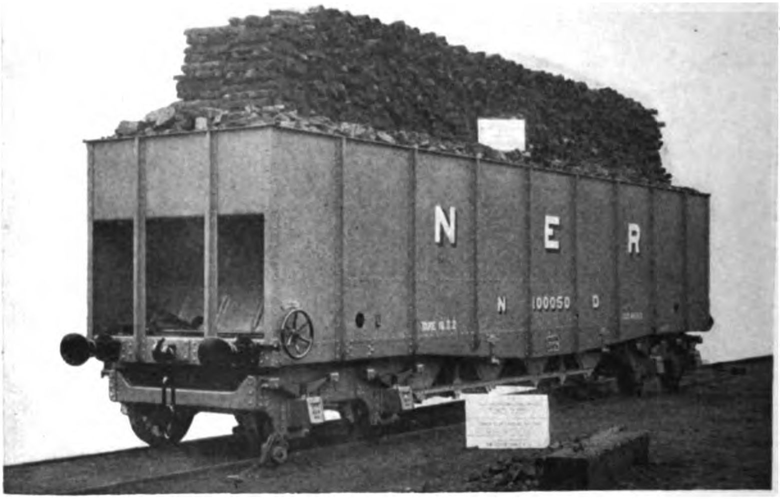

FIG. 97. TESTING A NORTH-EASTERN HOPPER. LOAD, 40 TONS OF COAL AND 60 TONS OF PIG IRON.

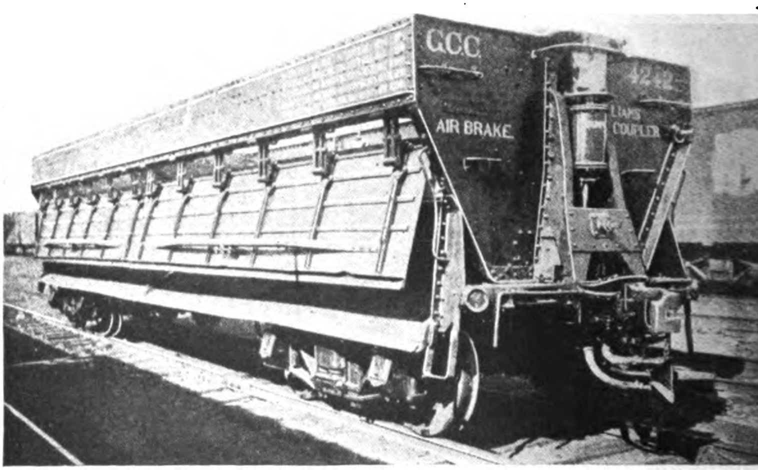

FIG. 98. A TRIUMPH OF MECHANICAL CONTRIVANCE, THE GOODWIN DUMP CAR.

ble combinations of these different positions. The car in our picture is fitted with discharge valves to be operated by compressed air, the power for which is supplied by the engine in the same way as the power for the Westinghouse air-brake. By coupling up the compressed air hose from car to car, it becomes possible for one man to discharge a whole train of Goodwin cars simultaneously, if desired. The cars can be emptied while running, and a most important advantage is gained by the fact that the load can be discharged completely clear of the car on the ground level with the track, there being thus no necessity for trestles upon which to run the car before unloading.

At the same time these cars can be built without the automatic discharge apparatus, and the triggers of the valve in that case are released by hand in the usual way. The car in our picture is a most completely fitted up vehicle; it has automatic couplers, and the automatic air and power hose couplers in addition.

The last picture included in this chapter, Figure 99, gives us a glimpse of a piece of work which these various types of coal and ore wagon which we have been considering are frequently called upon to do. The shipping trade, whether for bunker or for cargo coal, presents, as my readers will readily understand, the greatest opportunities possible for shipping in large quantities, and according to the latest scientific methods. Our picture shows us one of the wharves in the Hamburg-American Steam Packet docks at Hamburg, and we can see there a train of Prussian State Railway coal wagons drawn up opposite the chutes down which the coal is just going to be discharged into the bunkers of the large Atlantic mail steamer lying alongside. The coal cars in the picture are each 4-wheeled vehicles designed to carry a load

of nearly 20 tons (20,000 kilograms). Like most coal wagons for continental railways they are fitted with swing doors, thus being different both from the ordinary English wagon, which has a drop door, and from the American gondola, which, as we have already seen, has either no doors at all or hopper doors in the floor. Many of them, like the wagon illustrated in Figure 87, have a brakeman's box at one end, though that feature does not appear in any of the wagons included in our picture.

FIG. 99. COAL TRAIN ON THE WHARF AT HAMBURG, PRUSSIAN STATE RAILWAYS.

X

Flat and Box Cars

The simplest form of vehicle for the transportation of goods is a plain platform mounted on wheels. A car of this type is shown in Figure 100, which represents a flat car for the New York, Ontario & Western Railway. This car is built of wood, with iron pockets arranged on either side of the platform, in which stakes may be fixed, if desired, in order to secure the load upon the car. This car was built by the railway company at its Middletown shops. It weighs 11¼ tons English, and has a carrying capacity of nearly 27 tons. It measures 38 feet long over end sills and 9 feet 6 inches wide over all. The trucks are of the usual diamond shape and are built of steel throughout. A feature of this car is that the platform is 9 inches lower than usual, thus adapting the car, if necessary, for loading very high materials. Cars of this type may be used for a variety of heavy, cumbersome loads, such as would not be taken in the ordinary box cars, as, for instance, machinery or castings, even when these are of considerable weight and dimensions. Thus, for instance, very long girders may be loaded, if necessary, on two or more of these cars coupled together. Lumber will frequently be within the capacity of one such car, but when necessary two cars may be used, and it is perhaps of interest to note that the plan of coupling two short cars together is practically the universal method in Great Britain of carrying timber by rail. The companion picture to this, Figure 101, shows us what may be

looked upon as the next stage in the development of the freight car body. This is the low-sided car built for the Lagos Government Railway in West Africa by Messrs. R. Y. Pickering & Co., of Wishaw, near Glasgow. This railway is of the 3 feet 6-inch gauge and the car is designed to carry a load of 16 tons on a tare of 7 tons 11 hundredweight. The car measures 32 feet long over all.

Our next picture, Figure 102, shows a car with the sides raised a stage higher. This high-sided gondola, as it may be called, was built by the Baume-Marpent Company for the Rosario & Puerto Belgrano Railway. The under-frame and side stanchions are built of steel, while the sides of the car are of wood, the planks being laid horizontally, according to the English practice. The bogies are of steel throughout, and of the American diamond frame type, while the buffing and draw-bar gear follows the English pattern. The body measures 38 feet 3 inches over all and 9 feet 4 inches wide. The car sides are 5 feet 3 inches deep from the top to the floor. The tare weight is 18 tons 10 hundredweight, and the carrying capacity just on 40 tons. The gauge of this railway is the standard Argentine 5 feet 6 inches. The longitudinal beam running across the centre of the car is intended for the support of tarpaulin if it should be necessary to cover over and protect the contents from the weather. Rings are provided attached to the stanchions along the car side to which the cords of this sheeting may be attached. This is a common method in England of protecting goods which it is not considered worth while to carry in specially constructed box cars. The doors of this wagon are of the usual Continental pattern revolving on hinges.

The next class of wagon is similar to the last one in general outline and the service for which it is designed,

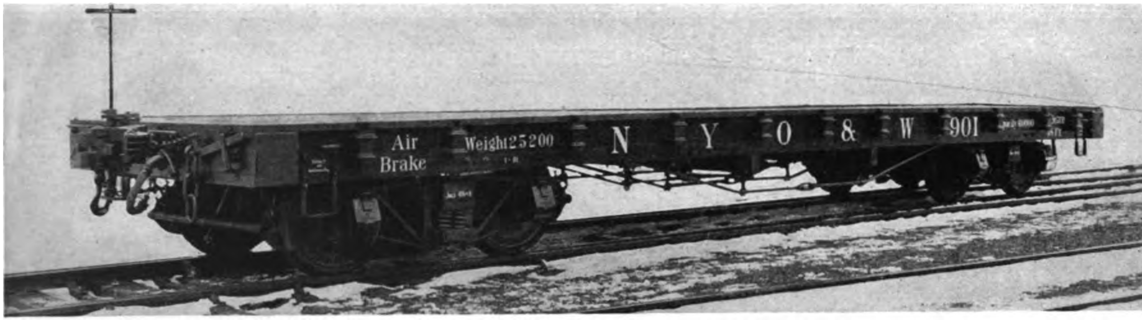

FIG. 100. FLAT CAR, NEW YORK, ONTARIO AND WESTERN RAILWAY.

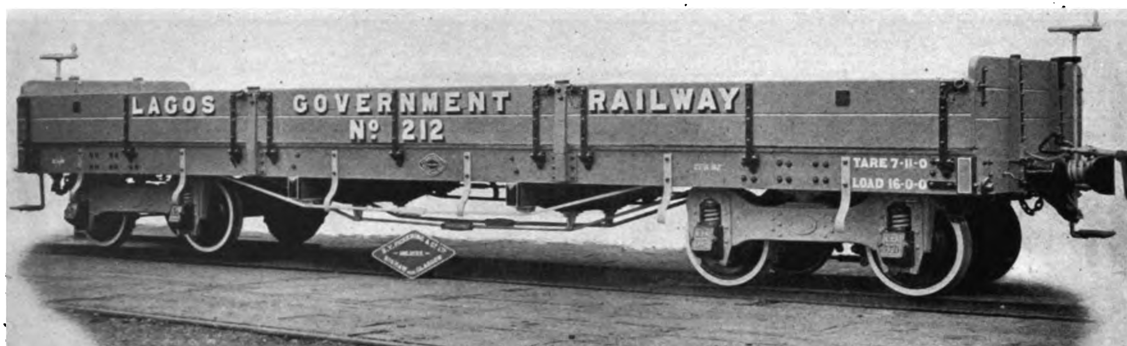

FIG. 101. LOW-SIDED CAR, LAGOS GOVERNMENT RAILWAY.

yet goes a step further in being provided with a permanent roof. It is illustrated in Figure 103, which represents a bogie wagon for the Shanghai-Nanking Railway. This wagon was built by Messrs. R. Y. Pickering & Co., of Motherwell, near Glasgow, to the designs of Sir John Wolff Barry & Partners, the consulting engineers to the railway. China is late in enjoying the privileges and advantages of railway travel. It is therefore only fitting that she should start with the benefit of other people's experience, and that Chinese rolling stock should be built on the most approved methods and according to well-tested and economical designs. The large wagon in our picture is quite in accordance with this supposition. It is built of steel with an under-frame of what is called the cantilever type on the method covered by the specifications of the Livesey-Gould patents. The truss rods in this type of under-frame have virtually become part of the framing itself. The length of the car inside is 37 feet 11$\frac{5}{8}$ inches, the width 8 feet 11$\frac{5}{8}$ inches, and the sides are 3 feet 6 inches deep. The wheel base of each truck is 6 feet and the trucks are spaced 25 feet 4 inches apart, centre to centre. The wagon has a total capacity of 1232 cubic feet. It is covered with a light roof of corrugated iron plates and is adapted to the carriage of bulky goods requiring some protection from the sun's rays. The drop doors provided on either side are of wood. The car is fitted like all the other goods stock for this railway with a combined buffer and draw gear, having automatic couplers of the Janney type. It is also equipped with a Westinghouse quick-acting brake as well as with an either-side hand-brake fixed about the centre of the car body. The wheels are of chilled cast-iron 2 feet 9 inches in diameter. This line is destined to run from Shanghai, the busiest of the Treaty Ports of China,

a city of nearly half a million inhabitants, up the valley of the Yangtsi Kiang to Hankow, a distance of about 600 miles. Near the latter city are coal mines which will in the future probably be of considerable importance and it seems quite possible that this railway is destined to be to China something of what the Midland has been to Great Britain.

For goods traffic this line has to compete with the cheap water carriage available. As this must always be much cheaper to work than the railway, the charges for the latter will, of course, compare unfavourably with those of the old-fashioned canal and river boats. The railway also has to bear a handicap in the shape of extra likin or inland revenue duties above those charged on goods conveyed by boat, but in spite of this handicap the goods traffic is growing at a considerable rate, because of the greater safety and speed which the railway affords. The two interesting and excellent specimens of freight equipment which we have already studied for this line show how carefully provision is being made to handle the large traffic which is growing up. For the sake of completeness, too, I may just notice that the passenger traffic has grown at such an extraordinary rate that the liberal supply of modern and splendid rolling stock with which the line has been equipped is already proving to be inadequate to the demand. The line serves a wealthy district, with a population that has shown itself quick to take advantage of the new travelling comforts which the railway has rendered available.

Between Shanghai and Soochow the railway runs for miles parallel with Soochow Creek. Along this waterway there used to be a constant service of passenger barges drawn by steamers, and it was thought, before the line was built, that no railway would be able to com-

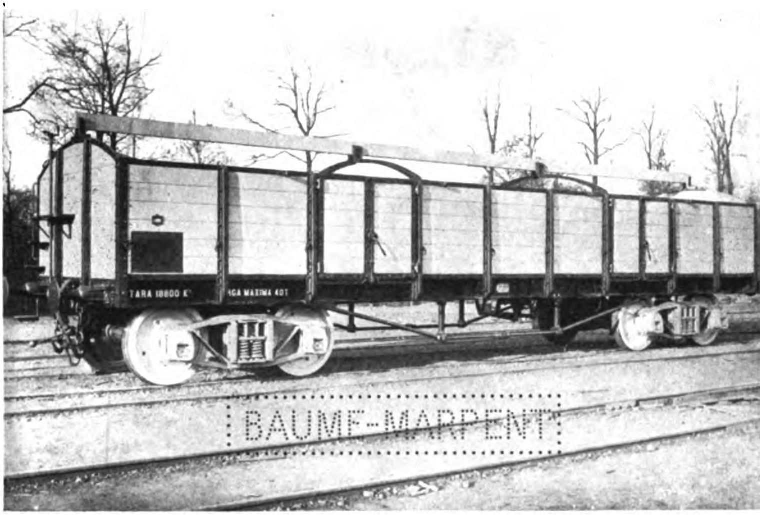

Fig. 102. High-sided Bogie Car for the Rosario and Puerto Belgrano Railway.

Fig. 103. Up the Valley of the Yang Tsi Kiang, Covered Bogie Wagon for the Shanghai Nanking Railway.

pete with these boats, but the result has proved that the comfort and speed of the railway has so attracted all the traffic to itself that the boats have now been taken off, and all this, it should be remembered, is taking place in the very district where, only a few years ago wealthy Chinese bought up the little Shanghai and Wu-sung line only that they might tip locomotives, carriages, and rails bodily into the waters of the Yang-tse.

Our next picture brings us back from the newest country in the world to adopt the railroad to the oldest. Here we have a true box car for the London, Brighton & South Coast Railway. This car has been built for the conveyance of meat, and other perishable goods, the body is 38 feet long by 8 feet wide, and the height inside from floor to roof 7 feet 6 inches. The wheels are spoked and measure 3 feet 1½ inches in diameter, the wheel base of each bogie being 5 feet 6 inches. The under-frame is entirely of steel and the body is double, formed of two layers of boards, the outer one being ⅞ inch and the inner ⅝ inch thick; these two layers of boards are spaced one inch apart, and the interval between them is filled up with silicate cotton. The object of this method of construction is of course to provide, so far as possible, insulation from variations of temperature which may occur outside the car.

The roof is double also, and, as will be seen from the picture, so arranged as to permit air to circulate between the two layers of roof board. The car is also fitted with refrigerator tanks, two large ones extending the whole width of the van at either end, with smaller ones in the centre. Vertical ladders similar to those adopted on American box cars are provided at ends and sides for the use of the men filling the ice tanks. The hand-brake is so arranged that it may be applied from either side

of the car, and it is worked by a hand-wheel shown fitted to the bottom of the car body in the picture. This car has been specially designed for the carriage of freight coming from the north of France in the company's steamers to Newhaven, and is intended to run between Newhaven and the Willow Walk goods depot in the south of London. A considerable quantity of fruit and vegetables is consigned to the London market over this route. This car has a tare weight of 19 tons, and can handle a paying load of 20 tons.

Our next example of a box car takes us East again to India this time. Figure 105 represents a large 40-ton steel car built for the Great Indian Peninsula by the Leeds Forge Company. The car measures 44 feet 2 inches over the buffers, with an extreme width of 9 feet 6⅝ inches, and is adapted to run on the 5 feet 6-inch gauge. The wheels are of the unusually large diameter for goods service of 3 feet 7 inches.

The necessity for putting these large wagons into service on an Indian railroad has arisen from the great and, to a large extent, sudden increase of goods traffic, which two or three years ago brought about almost a crisis in the Indian carrying trade. As we shall see in the next chapter the rapid increase of business necessitated the equipment of goods trains with continuous brakes in order to expedite working. It will be noticed that the large bogie wagon in our picture is fitted with the automatic vacuum brake, the coupling hose being carried on a plug suspended from beneath the head stocks of the car. The Great Indian Peninsula controls one of the most extensive railway systems of that vast country. From its geographical position as connecting with Bombay, which is practically the main line terminus of the English mail steamers, this road has the distinction of

FIG. 104. INSULATED BOX CAR, LONDON, BRIGHTON, AND SOUTH COAST RAILWAY.

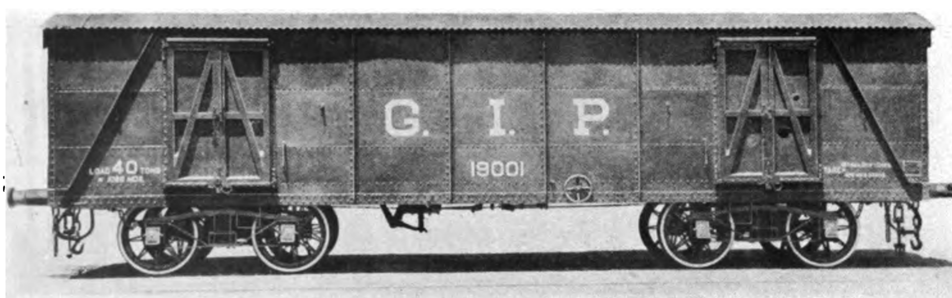

FIG. 105. SHEFFIELD TWINBERROW STEEL BOX CAR FOR THE GREAT INDIAN PENINSULA RAILWAY.

a share in the most important through traffic of India, which includes the Joint Bombay and Calcutta mail express, which runs weekly between the great Victoria terminus in Bombay and Howrah, Calcutta, in connection with the Peninsula and Oriental mail steamers. This train is a strictly limited one in fact as well as in name, accommodation being provided only for 32 first-class passengers, of which four ladies may be arranged for in a special sleeping compartment, with servants and baggage. The train leaves Victoria Station about four hours after the English mail steamer is signalled. The run across India, via Jubbulpore, is booked to take 40 hours. Similar arrangements are in force for the special postal services from Bombay to Madras, 26 hours, and from Bombay to the Punjab, the time to Umballa being 32½ hours.

The Great Indian Peninsula has an alternative route to Calcutta via Nagpur, by which one mail train proceeds daily, as well as the one by the northern main line. A feature of their service, which is now engaging the serious attention of the company's engineers, is the crossing of the great Ghats, which have to be encountered by all trains going east from Bombay. The northern main line, to Jubbulpore and Nagpur, climbs up the Bhore Ghat, while the line running south to Hyderabad reaches the great inland plateau of Central India by the Thul Ghat. In order to economise in the capital outlay required to surmount this high mountain fringe which extends along the whole of the west coast for over 700 miles, the railway was laid out on the switchback plan with reversing stations at intervals. In order to work the heavy traffic over these Ghat inclines, some very powerful 2-8-4 tank engines have recently been put into service. These engines are designed to haul a 350-ton train up the Ghat whose steepest grade is 1 in 37 at a speed of 10

miles an hour. On goods trains working over the Ghats special 20-ton incline brakes are marshalled next to the engine, so that communication may be established between the engine men and the guards in charge of the train.

Our next pair of pictures take us to North America. Figure 106 shows us a large modern box car for the Missouri, Oklahoma & Gulf. This car was built by the Barney & Smith Car Company. It represents the most recent American development of the box car. It is designed to carry a load of 35 tons 14 hundredweight English, on a tare weight of 16 tons 18 hundredweight. The inside length of the car is 36 feet, the width 8 feet 6 inches, and the height 8 feet. Access to the interior of the car is gained by one large sliding door on either side. This little road operates a small branch line lying in Indian Territory, and partly in Oklahoma. It connects for through traffic at two or three points with the Missouri, Kansas & Texas, its southernmost junction being at Denison, just south of the Red River.

As we have already seen with reference to Figure 104, there is one further special development of the box car for perishable traffic when a car of this type is equipped with refrigerating apparatus. As in the case of the London, Brighton & South Coast car, there described, the refrigerator differs from the ordinary box car only by reason of the insulating devices adopted in its build. In the winter-time in America the opposite precaution to that implied in the construction of a refrigerator frequently becomes necessary. For instance, early fruits and vegetables, say from Florida, cannot bear exposure without injury to the climatic conditions of the North, and if packed simply in an ordinary box car, will inevitably be frozen and spoilt in transit to the great

FIG. 106. BOX CAR, MISSOURI, OKLAHOMA AND GULF.

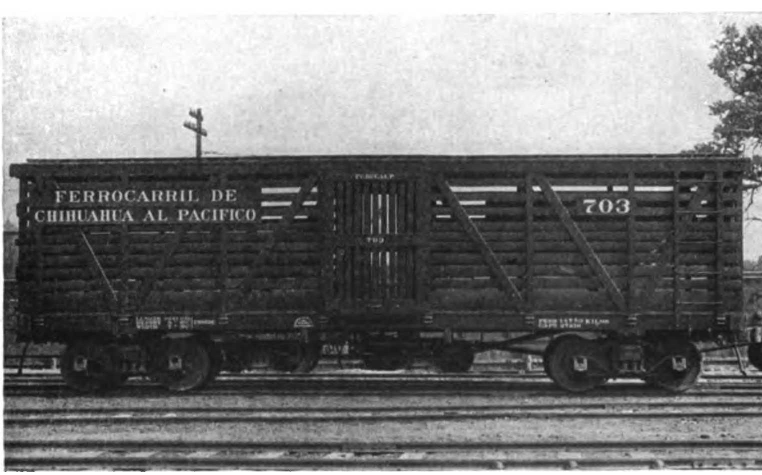

FIG. 107. STOCK CAR, CHIHUAHUA AND PACIFIC.

detriment of their quality and consequent loss of value. For this class of traffic, then, as well as many others, it has become necessary to introduce box cars which may be artificially kept at a required temperature. In build, these cars resemble a refrigerator, being constructed with double bodies, packed with insulating material, but instead of the ice tanks of the refrigerator car, they are equipped with a stove fixed below the level of the car floor, and automatically fed with petroleum from a tank. The products of combustion from this stove are delivered into a pipe fitted between the frames, and running to one end of the car where it turns upward, passing through the body of the car within a kind of cupboard, and terminating in a small cowl above the car roof. Both these classes of car are, from the constructional point of view, to be classed with the ordinary box car. A further subdivision of the same general class is to be found in the stock car or cattle truck, as it is termed in England. In Great Britain, these vehicles as usual run on four wheels, a space is provided between the lowermost panels and the floor to facilitate cleaning and the removal of straw, and the upper panels of the body are entirely wanting so as to permit the free circulation of air in the car. Very old wagons were often built without roofs at all, but it is now the invariable custom to roof all these cars in. To prevent injury to the animals carried in these wagons, they are always fitted with spring buffers and not infrequently with standard passenger screw couplings. As live stock trains are frequently worked on a fast schedule, many British cars of this class are now fitted with continuous brakes, either air or vacuum. A still more recent development is to be seen in some cars used specially for prize beasts going to or from cattle shows. In these cars a drover's compartment is provided at one

end, the whole arrangement being not dissimilar to the horse box already illustrated in Figure 78, except that the stock car is usually longer. In these latest types of cars protection from sun and rain is afforded, while at the same time, sufficient ventilation is secured by the upper portion of the car body being constructed of louvred boards. Figure 107 shows us a stock car for the Chihuahua & Pacific Railroad. Like the vehicle shown in the preceding picture this car was built by the Barney & Smith Car Company. In this car the wooden slats, of which the body is composed, are placed, not continuously, but with intervals between so as to allow for sufficient air circulation. This car measures 36 feet 6 inches long inside and 7 feet 3¼ inches wide, while there is a clear height inside of 8 feet 6¼ inches. The underframe and trucks are of the standard type, and do not call for any special remarks.

Chihuahua is 225 miles south of El Paso, on the Mexican bank of the Rio Grande, and a little over 999 miles north of Mexico City. El Paso and Mexico City are of course joined by the main line of the Mexican Central Railway, and through Pullman sleeper service is in daily operation between these two points. From Chihuahua the little line, to which the stock car in our illustration belongs, extends westward to the foothills of the Sierra Madre, which is virtually an extension of the great Pacific Coast range of North America. On reaching the mountains it turns north for about 35 miles, and finally terminates for the present at a little place called Temosachic. The total length of the road is only about 173 miles.

Our next picture takes us to quite the other end of the American continent. From the subtropical heat of Mexico, we pass to the snows of the Far North. Figure 108 shows us the Canadian Pacific Railway's sidings and

elevators at Fort William, at the northwestern corner of Lake Superior. The huge elevators, and the long lines of cars, show that Canada is something else than "our Lady of the Snows," as a poet once rashly called her. The Canadian northwest is already one of the great granaries of the world, a position which year by year increasing immigration and development enables it more completely to fulfil. Our picture gives us a glimpse of the city looking westward. The shore of the lake just comes into one corner of it. On the right hand, as you look at the picture, the blurred outline of a row of cars shows where a heavy freight train, laden with wheat for the eastern seaports, is just pulling out from the siding. The rows of cars standing waiting in the sidings in the picture, empty box cars waiting to proceed west to be loaded in their turn, and lines of flat cars laden with lumber from the mountains, all tell their own story, and the reason I have inserted this picture is that it may bring home more visibly to our minds the idea of the generalship and organisation which is required in the car superintendent's office. Normally the working of a great railway goes on so smoothly that outsiders, and possibly, to some extent, insiders, too, scarcely give a thought as to the means by which the great result is brought about, but occasionally it happens that you may read in the papers of some car famine in the North-west, or discover that, for some reason or other, the usual smooth working of the railroad has broken down. Even then, many of us, especially if we happen to be sufferers by the delay, are apt rather to content ourselves with grumbling at it, than to stay to think how it is that these delays are so infrequent and so noticeable therefore when they do occur. The car superintendent is a general in command of a vast number of units. If we take, to

look at the first record which comes to hand, a recent statement of the equipment owned by the Northern Pacific Railway, we find that a total of 31,000 freight cars, not counting the cabooses for the accommodation of the crews of the freights, are under the control of the car superintendent of that railway. In trying to estimate the work of this officer, we must remember that every car, wherever it is, and whatever it is doing, represents a certain amount of capital which has been spent upon it, but that capital is only earning interest just so long as the car is in movement carrying freight. The business of the car superintendent, then, resolves itself into a never wholly successful, but at the same time, never-failing attempt, to keep all his cars loaded, and moving. I have said that this attempt is never wholly successful, and a little thought will show us that this ideal can never be completely realised. Loading and unloading cars are operations which must consume a certain amount of time, and it frequently happens that unloading especially may consume quite an unreasonable amount of time. The consignee, for instance, to whom a carload of goods is sent, may sell the freight before it has been taken out of the car. If he has a deal of this kind impending he will naturally like to hold the car as long as possible until he knows what he wants to do with its contents. This happens more or less on all the railways all over the world, and to protect themselves against undue detention on the part of their customers, railway companies usually make a charge called demurrage, which is virtually a rent charged for the use of the car for every day that it is held beyond an agreed time. Then, too, it very seldom happens that it is possible for a railway, wherever it is situated, to obtain loads for its freight cars both ways, thus, for instance, in America, the great stream of trunk

line traffic sets from the west, eastward, and there is nothing at all corresponding in volume to this tide in the way of traffic flowing westward; so, too, in Great Britain, the chief coal-carrying roads there find their main volume of traffic flowing from the north towards London, and on the main line of one of the great English freight-carrying roads, you may see any week-day a continual procession of loaded trains passing southward, while, for the most part, the north-bound trains consist of long strings of empties. This difficulty of balancing the movement of loaded cars is one which no ingenuity on the part of the car superintendent can entirely overcome, because it depends upon circumstances, economic and social, which are beyond his power to control. All that he can do, then, is to try and reduce the mileage or distance travelled by unloaded cars by every means in his power.

To do this, he must know two things: First of all, where and when a demand for freight tonnage is likely to spring up, and what kind of cars will be best adapted to meet that demand. Secondly, he must know what are the nearest points where empty cars are lying from which the demand can be supplied. The intelligent anticipation of demands of this kind can of course come about through an intimate acquaintance with the business conditions of the territory which his road serves, and if that territory be an extended one, the difficulty of obtaining an intimate acquaintance with those needs increases in proportion to the wide variety of local circumstances with which his system comes in contact. One or two instances will show the kind of anticipation which is required, and may be practised by this important official. For instance, he knows that every year the harvest falls to be moved if his road touches at all an agricultural district. He is aware, to within a few days, of the time when this move-

ment may normally be expected to begin. He will, therefore, seek to have as many cars available for the movement lying at suitable points, by the time that movement sets in. So far, the work might be considered to be largely routine, but notice how many variations may occur from the normal. To begin with, there may be an unusually heavy harvest. Trained observers will be able to inform our car superintendent of this fact weeks beforehand, and he would therefore naturally think to prepare for an unusually heavy traffic, but this bumper harvest may result, not in increasing, but in actually checking for a time, the movement of freight traffic resulting from it, by reason of the lower prices which it will tend to bring about. Farmers will, if they can, try to hold back their wheat, or whatever the crop may be, in the hope of obtaining better prices. Now, if our car superintendent can have an early knowledge of this fact, or be able to deduce the result from his own reasoning about the circumstances presented to his knowledge, he will avoid the mistake of having an undue amount of rolling stock in those districts, and try to keep his cars, as far as possible, elsewhere, where perhaps there may be a demand for their services.

One of the things which most tests the car superintendent's department, is a sudden and quite unexpected demand for cars springing up. Especially is this the case if the demand is for a particular type of car, and the multiplication of special types of car renders it increasingly difficult to keep such cars profitably at work. The development of special types of freight car is therefore a matter which no railway company is likely to actively encourage. One car adjusted to all general uses would be far more profitable for them. On the other hand, in some cases the development of a particular type of car

FIG. 108. ONE OF THE WORLD'S GRANARIES, SIDINGS AND ELEVATORS, FORT WILLIAM, CANADIAN PACIFIC RAILWAY.

is an absolute necessity if certain classes of business are to be undertaken at all. An instance of this occurs in the well-known case of the tank car. The demand for these cars is practically regular and continuous, but they have, of course, the disadvantage which is inseparable from their use, that they can only be loaded one way.

These instances taken almost at random will help us to realise a little the kind of difficult problem which is being solved by our railways, in whatever country of the world we may live, every day in the week, but another thing which a car superintendent has to take into consideration, besides all probable or possible demands for cars on the part of traders, is his own ability to supply the cars. For this purpose he must know, not only what cars he has, but he must also know where to lay his hands on them. Thus notice the case of the Northern Pacific, which I quoted at starting. The main line of this road stretches 2053 miles between St. Paul and Portland, and its branches extend over many hundreds of miles besides. Now, the movement of a car from point to point of an extensive system like this takes time, and costs money. It is therefore essential that the car superintendent should know whereabouts in all this wide stretch of country, for which he is responsible, the cars he wants are to be found. This knowledge is conveyed to him by the daily reports furnished to his department by station agents and conductors of freight trains. In the case of roads having very extensive mileage the immense physical difficulty of keeping in touch with cars so widely scattered is mitigated by cutting the road up into divisions, and assigning a certain number of cars to each division. We had an instance of that in the large North Eastern coal car in Figure 97. But even this is not enough; the car superintendent must not only know where

his cars are so that they can be moved over the shortest possible distance with the least possible delay to receive a load, but he must also know what condition the cars are in. He must know, for instance, that while a certain car may be at a station only a few miles away from a point where it is wanted to take, let us say, a load of furniture, and while the car is perfectly fit to travel and in road-worthy condition, yet perhaps the roof is not sound, and if he sends that particular car on that particular service he may involve the road in a claim for damages, and it may therefore actually pay better to bring another car from much further afield, but in absolutely perfect condition. Then, again, he will want to get the defective car into the repair shops as soon as may be, and, if the defect is not serious, he will try and load the car towards the nearest repair depot which he may have.

Besides all this generalship in the head office of this important department, a great deal also inevitably depends upon the rank and file of the men employed, and the most perfect system is that which combines a real control in all things essential by the chief of the department, with a large amount of decentralised authority, giving to the men actually out on the road the power, and also the responsibility, of being able to act promptly on their own initiative when required.

All that I have hitherto been describing concerns the comparatively simple matter of the use by a railroad of its own cars. The question becomes immensely more complicated when, as so often happens, the use of foreign companies' cars comes into question. In America, railways form among themselves "car service associations" and other mutual organisations, whose object is to secure fairness in the business relationships of the different roads comprising the body. In Great Britain

these duties come under the work of the Railway Clearing House. Railroads usually now charge one another demurrage for the use of cars, with a special fine to which any company becomes liable for retaining a foreign car for more than an agreed number of days, usually 20. A foreign car, I should perhaps explain, means any car when running on the road of another company than that to which it belongs.

In a deeply interesting sketch of the American freight car service written twenty years ago by Theodore Voorhees, vice-president of the Philadelphia & Reading, he describes in detail the wanderings of a car over foreign roads which lasted for sixteen months and one day. In this time the car travelled practically over the whole of the United States east of the Mississippi. Once, when its home officials were eagerly looking for it, it actually passed through the Indianapolis depot of the company to which it belonged, but it was loaded, and made no stop, and seems to have eluded the notice of those who were so keenly on the lookout. This is a sample of the kind of wanderings which are possible in a country of wide geographical extent like America, where the actual physical task of keeping in touch with thousands of cars is no light matter.

In England, most of the cartage service, by which goods are conveyed to the companies' depots, is performed by the railway's own carting staff. Some companies, notably the Great Western, are beginning the extended use of large steam-driven lorries for this purpose, but however the goods are taken to the station from which they are despatched, the movement of the freight on to the rails usually begins in the evening, after the close of the business of the day, from the offices and warehouses of a great city. Whether in London, or

New York, this is about 6 P. M., and as the loaded cars are moved out from depot and warehouse into the goods yard, they come then under the control of the yard-master, upon whom, with his assistants, falls the ultimate responsibility of making up the cars into trains and despatching them to their different destinations. The make-up of trains for important points is a comparatively simple matter. It will be easy to provide an adequate train load, for instance, between London and Manchester, or New York and Pittsburg, but greater difficulties begin to be encountered when it becomes necessary to deal with a consignment for some out-of-the-way little place. If the consignment be large enough to have a car for itself, a "straight car" as it is called in American railway parlance, the yard-master's care must still be exercised to see that it goes by the train which can most conveniently make a stop at the right junction point at which the car may be transferred to a local goods or pick-up freight. In the case of small consignments, such as would not justify the use of a car or wagon, the difficulty becomes of course proportionately greater. The object of the yard-master's care is constantly to pass goods over his road with the least possible expense for handling. The continuous demands of British traders and shippers to have vehicles allotted to their sole use for small consignments has been one of the great causes of the small type of wagon employed in Great Britain, and is still to-day one of the chief difficulties in the way of employment of larger wagons.

Our next picture, Figure 109, shows us an instance where it has been found possible for an English line to bring into use trains of bogie wagons. This picture represents a train loaded with pottery ware leaving Horwich, on the Lancashire & Yorkshire Railway. The

Fig. 109. Among the Pennines. A Lancashire and Yorkshire Goods.

train is composed of bogie open wagons each carrying 30 tons dead weight on a tare of 14 tons 18 hundredweight. The wagons measure 35 feet over buffers, and about 7 feet 3 inches over all. They have steel underframes and wooden bodies, and those in our picture have either-side hand-brakes applied by the usual English lever arrangement. Some of the large wagons built by this company, however, follow the example of other recent practice in having a screw brake gear. This railway has also put into service a good number of bogie box cars. Cars of this description, whether box or open, can be profitably used in connection with the shipment of large manufacturers in any line of business, but even here difficulties arise from the fact that access to warehouses and the like is often gained by means of small turn-tables which have been constructed to take the old 4-wheeled stock, and in attempting to work bogie wagons over turntables of this description, which, of course, can only be done by placing one bogie at a time on the table, there is constant risk of the whole vehicle leaving the road, and thus causing expense and delay. This picture, however, is an evidence that English railway men are fully alive to the importance of securing similarly favourable results to those obtained by their American brethren wherever the improved methods of working can be adopted.

Another example of a special train for special service is shown us in Figure 110. The Illinois Central handles a considerable amount of traffic in fruit and vegetables coming from the Southern States, and shipped at points in the States of Mississippi and Tennessee for Chicago and the North. Traffic of this kind must be worked through on a fast schedule, similar to that of a passenger train.

Our picture shows the Banana Express approaching Wetaug, Illinois, on the main line, about 18 miles north of Cairo. The train, on the occasion when our picture was made, consisted of 34 cars, weighing in all 1045 tons gross, the net load being 433 tons. The train, like most American fast freight trains, is being worked by a powerful six-coupled engine of the Mogul type.

At New Orleans the Illinois Central devote one freight house, out of the 25 belonging to the road which line the levees within the city limits, exclusively to banana traffic. This house has a capacity for 40 carloads of bananas, and fruit is transferred direct from the steamer to the warehouse, from whence it is loaded into specially constructed fruit cars and despatched northward by fast freight trains such as the one shown in our picture.,

As an instance of English methods in handling fruit traffic, we have in Figure 124, which the reader will find in Chapter XI., a Great Northern fruit car linked with a North British snow plough, under the title of "Winter and Summer." This fruit van, as is usual in British practice, runs on four wheels only. It is designed to carry a load of 5 tons on a tare weight of 8 tons 6 hundredweight. Both under-frame and body are built of wood, and the van is fitted with air and vacuum brakes and screw couplings. The wheels are similar to those used under passenger cars, these vans frequently being worked on passenger trains, and also frequently made up into trains to be worked, as in the Illinois Central example which we have just seen, on a fast schedule. These special fruit, or other goods trains of this character, are worked through, in every respect, as passenger trains, accompanied by passenger brake van, and hauled by passenger engines, frequently by one of the large Atlantics. Trains of this description and class

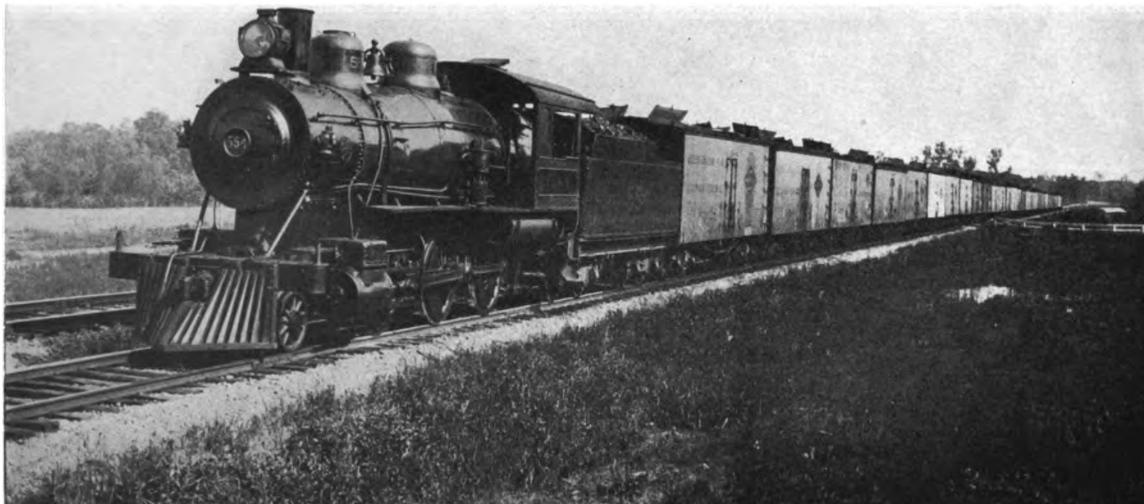

FIG. 110. FROM THE GULF TO THE LAKES. A BANANA SPECIAL, ILLINOIS CENTRAL RAILROAD.

are used to deal with the London and Bradford traffic, and also with the Anglo-Scottish goods traffic to quote the two perhaps leading examples. For the sake of completeness, I may as well add that most of the express traffic between London and the great towns of the Midlands and north of England are now worked over all the competing lines in this way. The van illustrated in Figure 124 is fitted with louvred panels along the top of the sides, and also between the cross braces of the body-frame at the bottom. A clerestory roof is provided, the sides of which are also louvred, and in addition, torpedo ventilators are fixed upon the roof on either side of the clerestory. Both side and end doors are fitted; the latter are made with the upper portions working on hinges as usual, while the lower part is arranged on a drop hinge to form a ramp. This ramp, when lowered, extends over the length of the buffers, thereby greatly facilitating unloading, and also enabling the van to be used, if necessary, for carriage or motor-car traffic. This van measures 21 feet 6 inches in length over the buffers, while the body is 18 feet long, 7 feet 8 inches wide, and the top of the clerestory reaches to a height of 12 feet 2 inches from the rail level.

One of the earliest goods trains in England, or indeed in the world, to be worked on a passenger schedule, and passenger equipment, was the well-known "Scotch meat and fish" of the London & North Western. This train runs daily, or rather nightly, between Aberdeen and London, where it terminates in the great North Western goods depot at Broad Street. Figure 111 shows us a typical fish van used in this London-Scottish service. It is a six-wheeled van painted and finished in the style of the standard North Western passenger stock, and, like the Great Northern van at which we have just looked, is

equipped with spring buffers, screw couplings, and continuous automatic brakes. The only difference between the finish of this fish van and passenger baggage cars, is in the upper panels, which, instead of being finished white, as in the case of the passenger stock, are in the same colour as the lower body panels. Louvred ventilators are provided, and also ventilating hoods at either end of the van fitted with gauze screens to exclude dust. The new method of obtaining light inside, by means of long strip panels of glass immediately under the eaves of the roof, will be noticed in this picture. Access to the van is obtained by two large sliding doors on either side, each of which has a slate panel about its middle line upon which directions may be chalked.

Figure 112 shows us how another British company with a large fish traffic deals with this kind of business. It represents a bogie fish brake for the Great Western Railway. It is practically an open 8-wheeled wagon, with a large guard's box built at its centre. This brake wagon can carry 8 tons of fish on a tare weight of 14 tons 15 hundredweight. The length over head stocks is 35 feet and the guard's box occupies about 7 feet of the length, extending in width all the way across the vehicle. Another type of this unusual form of goods wagon runs on 6 wheels. Some of the guard's boxes are fitted with built-out wings for lookout, as in the case of passenger vehicles. These vehicles are used on the special fish trains running up from the west of Cornwall. The guard's box is provided with a stove for use in cold weather, and the draw gear and brakes are similar to those used on passenger stock.

While speaking about these long-distance through goods trains, it may be of interest to mention the method of working adopted in handling the trunk line traffic on

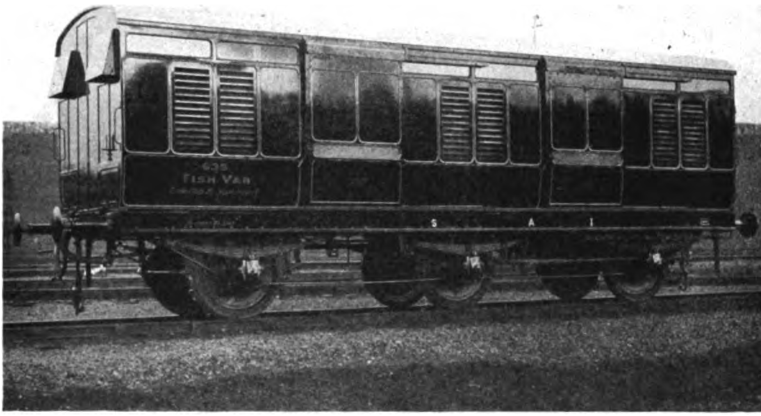

FIG. 111. BOX VAN FOR THE "SCOTCH MEAT AND FISH" SERVICE, WEST COAST ROUTE.

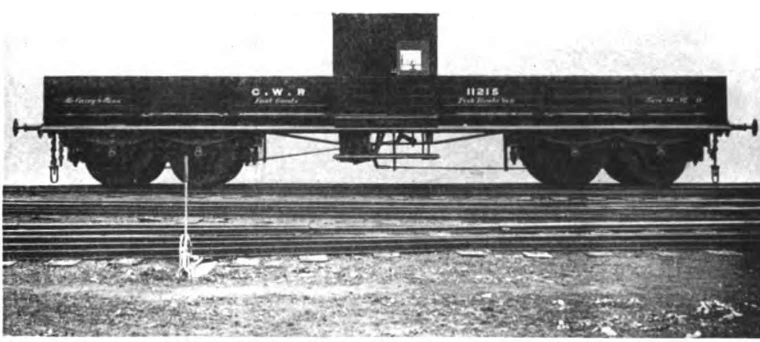

FIG. 112. BRAKE VAN FOR FISH SPECIALS, GREAT WESTERN RAILWAY.

the big railroads of America. We may take as our example the Pennsylvania. On this railway there is naturally a tremendous volume of freight traffic from western points, like Chicago, St. Louis, and Cincinnati, and also coming over the great lakes in summer-time via Cleveland, to be hauled to the Atlantic seaboard. This trunk freight traffic is hauled in trains which run from one great centre to another, a fresh train crew and locomotive taking charge at each of these depots. One of the most important, if not the most important, of these is at Altoona. Through this depot there passes a continuous stream of loaded trains bound east, and another continuous flow of empties in the opposite direction. Altoona is situated 1180 feet above sea level among the foothills of the Alleghenies. Trains arriving from the west have of course climbed over the summit, which is only 11 miles away, at Gallitzin. Just east of Gallitzin tunnel, by the way, the line enters upon the famous horse-shoe curve.

Freight trains are worked over the mountains in a practically continuous stream, with the train engine leading, and a heavy consolidation pushing behind. Very often only a few yards separates the train engine of one train from the pusher of the preceding one. As the trains arrive at Altoona, the locomotive and caboose is taken off and the train handed over to a switching crew. A heavy yard engine now takes the train in hand, and it is worked through the station to the yard on the eastern side of the city, where it is handed over to another road engine and crew to resume its long journey to the Atlantic coast. Meanwhile, the locomotive which brought it on the last stage from the west, has been moved to the round house of the western yard to be cleaned up and prepared for a return journey.

XI

Goods Traffic—Special Loads

We have already seen that, from the point of view of railway working, a car superintendent would far rather have as few types of car for his freight traffic as possible. But there inevitably do come times when the use of a special type of car becomes an absolute necessity. I am not now speaking of the desire for economy of working, but of those cases where the use of a special type of car is imposed by the physical nature of the load to be carried. The first example of this comes before us in our next picture, Figure 113. This represents a well-wagon built by the Great Northern Railway at their Doncaster works for the carriage of very heavy and cumbersome loads. The well sunk in the centre of this car renders it useful for carrying such things as boilers, armour-plates for battleships, and large pieces of machinery, which would not, but for this provision, clear the loading gauge. This crocodile wagon has a tare weight of 27 tons 7 hundredweight, and is constructed to carry a load of 40 tons. It should be noticed that with certain classes of load the tare weight will be increased by another 2½ tons owing to the use of heavy longitudinal timbers to pack the load. The body of this car is built of four parallel longitudinal steel girders, strongly braced together. It is carried on two diamond framed bogies of an American type with helical springs, but has spoked wheels and oil-filled axle boxes. Our picture shows the new car undergoing rather a novel test in Doncaster yard.

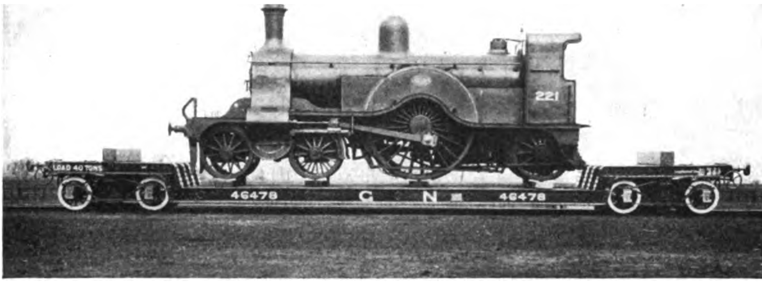

FIG. 113. A NOVEL TEST. OLD SINGLE EXPRESS LOADED ON A CROCODILE WAGON, GREAT NORTHERN RAILWAY.

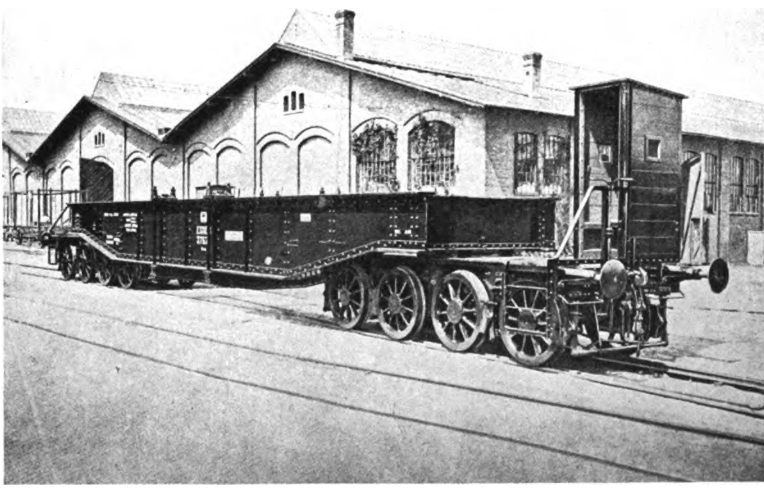

FIG. 114. SIXTEEN-WHEELED CROCODILE FOR SHIP'S ARMOR AND GUNS FROM THE KRUPP WORKS AT ESSEN, PRUSSIAN STATE RAILWAYS.

One of the old Stirling 8 feet single engines was loaded on to the car which was then moved about the yard in order to test its behaviour. The locomotive weighed about 4 tons over the designed carrying capacity of the wagon. Of course a load like this would not pass the loading gauge, and a test of this novel kind was only possible in the yard where the passage was unobstructed.

Our next picture, Figure 116, shows an even larger platform wagon than the preceding one. It is a 16-wheeled car for the Prussian State Railways, and is designed to carry a load of 80,000 kilograms, or approximately 79 tons. As our picture shows, it is fitted with a brakeman's box, and, like the Great Northern example, has spring buffers. It is also provided with screw couplings, and the bogies have inside bearings and are, more or less, of the type used for locomotive trucks.

This car has been specially built to deal with large castings and armour-plate coming from the famous Krupp works at Essen. Essen is a few miles from Alten-Essen on the main line between Berlin, Hanover, Dortmund, and Dusseldorf, and is in direct railway communication, via Hanover, with Hamburg and Kiel, and via Münster with Bremen. It is, then, readily possible, by means of the Prussian State lines, to convey either machinery or ships' plates from Krupp's extensive shops to any of the great shipping ports and dockyards of the North.

Our next picture, Figure 115, again shows us a yet larger car of the same general type. This is a 24-wheeled car, built by the Pennsylvania Railroad Company at their Altoona shops for the conveyance of very heavy castings. Like the Prussian State wagon just described, it has a hand-brake fitted at one end. It is also fitted with the air-brake like the rest of the Pennsylvania Railroad stock. As will be apparent from the pic-

ture, this immense vehicle really consists of two flat cars with a bridge between. Indeed, it will be noticed that the flat cars bear two distinct numbers, so that it is perhaps rather an exaggeration to describe this piece of apparatus as one vehicle. Each of the flat cars which form the basis of this remarkable carriage consists of four heavy steel girders, carried on two 6-wheeled trucks. As in the case of the Prussian State Railway crocodile, these trucks are all fitted with inside bearings.

Each of the flat cars weighs nearly 19 tons 4 hundredweight. The large connecting bridge between them weighs 10 tons 8 hundredweight, and in the picture the car is shown loaded with a Krupp gun, the weight of which was 62 tons 10 hundredweight. The total weight of car and load on the occasion when our picture was taken thus amounted to rather over 113 tons, but owing to the elaborate and careful design of the car the weight on each axle was only 9.4 tons. All the measurements which I have given are in English tons. The actual occasion of this remarkable consignment was the conveyance of a heavy naval gun for one of the United States battleships from the works at Philadelphia.

But cars of special design are not only, or exclusively used, for these war-like purposes. Our next picture, Figure 116, shows us a ramp car for the Egyptian State Railways. At many stations on the lines of the Egyptian State there are no suitable docks at which vehicles can be loaded on to the railway cars. To meet the difficulty caused by the absence of these appliances, the car in our picture has been designed. It consists, as my readers will see, of a flat car, or platform wagon, at one end of which is a strong hinged ramp composed of two steel girders connected by cross pieces, and of such a size that when lowered it presents an incline up which even the

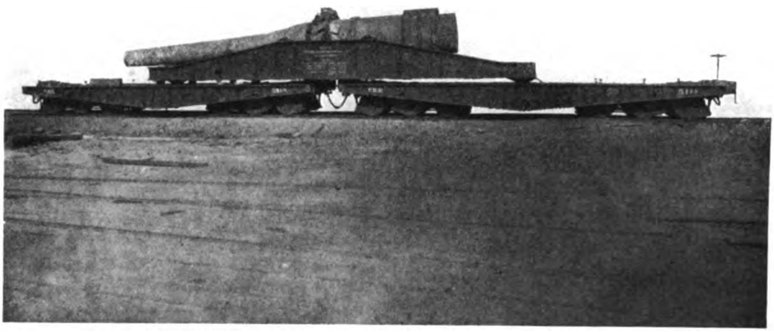

FIG. 115. CARRYING ONE OF A BATTLESHIP'S HEAVY GUNS, PENNSYLVANIA RAILROAD.

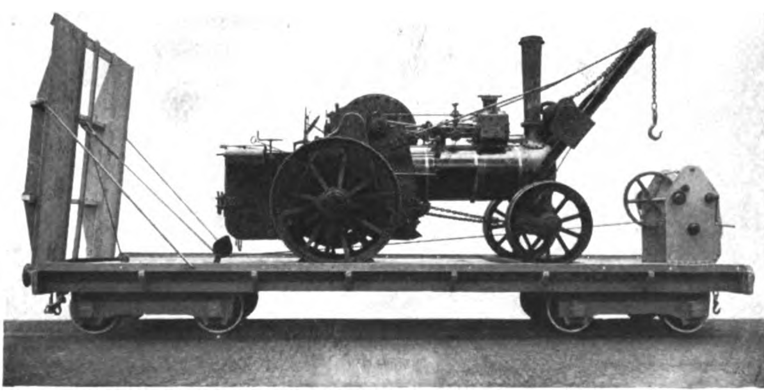

FIG. 116. AT WORK AMONG THE FELLAHEEN, AGRICULTURAL ENGINE LOADED ON A RAMP WAGON, EGYPTIAN STATE RAILWAYS.

heaviest road vehicles can be readily moved. At the opposite end of the car to that at which the ramp is fixed is provided a stout windlass. The windlass frame consists of steel plates built into the frame of the flat car, and a steel wire rope is provided which passes through a pulley fixed to the deck of the car and which is shown in the picture, the free end being then secured to a clip on the hinged ramp. The method of operation of this ramp will be sufficiently clear from the picture. The ramp is, of course, so proportioned that when raised, as our picture shows it, its height is such that it will still clear the loading gauge of the railway. When the ramp has been lowered for service the wire rope may be uncoupled and attached to the wheeled vehicle which is to be loaded on the car. This vehicle, whatever it is, may then be hauled up on to the car bodily by means of the windlass. The windlass is arranged to be worked by hand.

This platform wagon is designed to carry a load of 25 tons. It measures 31 feet long and the ramp itself measures 10 feet 11½ inches. The frame of the wagon consists, as in the other cars at which we have been looking, of four steel girders, which in this case are of Fox's pressed steel. The over-all width of the car is 10 feet 7 inches, probably a record width for a standard gauge wagon. Slung underneath the car at the end where the ramp is, may be noticed a pair of struts. When it is desired to load the car these struts are lowered, and adjusted so that they carry the weight of the ends of the car and its load which is thus lifted completely off the bogie wheels. These struts bear on the top of the rails. The buffers at the ramp end are hinged so that they can be lowered out of the way when the ramp is brought into use. The windlass provided is a double-purchase crab

winch and is designed to lift a load of three tons direct from the barrel. The large cog wheels of the winch are 3 feet ¾ inch in diameter. The wire rope is 100 feet long and has a breaking weight of 22 tons. The truck wheels are of solid steel and measure 2 feet 4 inches in diameter. In our picture this ramp wagon is shown loaded with a traction engine built by Messrs. J. & M. McLaren, of Leeds. This engine is designed to perform a great many useful functions in a country where adequate appliances are not too numerous. It is a traction engine which can also be used for drawing steam ploughs, while at one end it forms a crane. Altogether both the agricultural engine and the very interesting railway car which has been specially designed to carry it, form examples of engineering skill which are of quite unusual interest.

It oftens happens that railway companies are called upon to transport articles which it is utterly impossible to carry over the ordinary standard gauge rail. Instances of this, which have recently occurred, are the removal of the huge casting forming the sternpost of the *Mauritania* from the works of the Darlington Forge Company, Ltd., Darlington, to the slip where the ship was built at Walsend-on-Tyne. This immense stern frame, which also included the brackets for the two inner propellers, weighed no less than 104 tons, while the rudder, which was also made by the same firm, had an area of 420 square feet and weighed 63½ tons. Or, to take another instance, a heavy consolidation engine for the 5 feet 6-inch gauge built by Messrs. Robert Stephenson & Co., of Newcastle-on-Tyne, for an Argentine railway, had to be taken across England to Liverpool for shipment. In both these cases, and many others like them, special arrangements for handling the traffic have to be

made by the railway companies concerned. Consignments of this character are usually moved on a Sunday when the line is free from traffic, and often such a trip involves having a train running on both lines of rail, up and down, in order to accommodate the cumbersome load. A train of this description can of course only be worked under the special and personal authority of the district superintendent, because all the ordinary block working has to be set on one side; in fact, so long as the trip is in progress, all other train service over the line must be practically suspended. The train conveying the load usually consists of a powerful crane or cranes marshalled with their jibs facing the load and ready for action in the event of any mishap being apprehended, and also of tool cars and a general set of break-down equipment.

The speed of such a train will of course be very low, probably not more than about 10 miles an hour. A consignment of this kind concerns the permanent way department almost as much as it does the locomotive and carriage department. The permanent way inspectors will usually add their share to the precautions which are being taken by securely clamping all facing points over which the load must pass on either road.

Another somewhat unusual consignment is shown in Figure 117. This represents a train of cars for the Baker Street and Waterloo Railway, being brought from the builder's yard in Lancashire to London by the London & North Western. The Baker Street and Waterloo is one of the most recently opened electric tube railways in London. In this picture we see the cars approaching London and soon to bid their last farewell to the light of day. They are being hauled to their destination by a standard 6-coupled with 5-foot drivers express goods engine.

The consideration of these heavy and exceptional train loads brings us face to face with a question which has met us several times during the preceding pages, but which I have been putting off until the present moment. The question to which I refer is, How may such heavy loads be kept under safe control? Long after continuous and automatic brakes had been invented, their use was restricted on all the railways of the world to passenger traffic, while the only attempt to control goods trains was by hand-brakes worked on the guard's van or caboose, and perhaps a certain number of other cars on the train, in conjunction with a steam or automatic brake on the engine itself. In England the engine brake for goods train working has usually been a steam brake, although frequently a Westinghouse air-brake. In America, the locomotive brake has almost always been of the latter type. Every English goods wagon has a hand-brake worked by a lever fitted below the level of the sole-bar, and with the handle working in a quadrant to which it may be pinned if required to hold the brake in position. On the continent of Europe the brake has usually been worked by a screw apparatus, several examples of which we have already seen in the pictures included in the present volume. In America, as has already been hinted, the braking was performed by means of screw brakes worked from above the cars, and as, for many years, most of the American freight traffic has been carried in box cars, this meant that men must climb to the top of the cars in order to apply the brakes. And to a train crew sitting round the stove in their caboose on a cold winter's night, when perhaps the car-steps and running boards would be coated with ice, there was no more dreaded summons than the terrible staccato whistle of the locomotive signalling "down brakes." It was a

Fig. 117. A Passenger Train by Goods.

The London and North-western bringing Tube Cars to London.

summons which meant extreme peril for every man whose duty it was to obey it. As we have already seen in discussing the design and build of freight cars, there is absolutely no protection for the brakemen when once they get to the top of the cars, but their own agility and care. A single false step or slip in the dark meant certainly disablement, probably death, and I suppose no one will ever know the number of lives sacrificed to this system of braking.

In England it is the custom to stop a train at the top of an incline while the guards run along the track pinning down the brakes of as many wagons as may be necessary to permit the train to descend in safety and under the control of the engine-driver. In Europe again, on the other hand, as we have seen already, brake boxes are provided on a certain number of wagons and cars in which brakemen may ride ready to apply or release the brakes according to signals from the engine. Of these methods of hand-braking, the one in vogue in America was unquestionably the most dangerous. In recent box cars, built for the Antofagasta and Bolivia Railway, a handrail is provided along the running board, similar to the one shown in Figure 91, for the Madras Railway ballast wagon, but there was no room for the provision of such handrails on most railways, because with that excrescence the car would not have cleared the loading gauge. It was only reasonable then that the movement towards some system of automatic continuous brakes should have begun in North America.

Closely linked with the question of braking comes that of coupling, and we may perhaps conveniently try to consider them together. In Great Britain and in Europe generally the usual method adopted for coupling for goods wagons is a chain of three large loose links.

Formerly men were required to go between the side buffers of the wagon to attach the link to the draw-hook of the next wagon, but the great danger involved in this proceeding led to its discontinuance, not, however, before many lives had been lost through men being crushed between the buffers of adjacent wagons. To obviate the need for porters and shunters going between the wagons, the shunting pole was devised. This consists of a long pole, with a hook at the end of such a shape that it is easy to get hold of a link with it and lift it on or off the draw-hook without the risk attendant on the old method.

In America again, and also in many other countries, especially on Colonial railways, a link and pin coupling was adopted. This was usually combined with a centre buffer or buffers. This again proved a most dangerous form of coupling for the men who were called upon to handle it. To guide the link of one car into the pocket provided for its reception on the next car was no easy matter, especially by night, and resulted in thousands of accidents of a more or less serious character. American engineers, therefore, went to work to devise some means of coupling which would obviate the necessity for men going between the cars at all. Their efforts have resulted in the adoption of some form of automatic coupler. Their use is now compulsory on all American roads. As I have already described the form of coupling used for passenger cars, I need not attempt to enter into the minute differences which exist between the forms used for passenger and freight service, the general principle and outline of the couplers being the same. In England the question of automatic couplings has been brought up from time to time, but so far hardly anything has been done in the matter. Some attempt was made

to make the use of an automatic coupling compulsory in England by law, as had been done in the United States, but so far these attempts have been successfully resisted by the railway companies and by the private owners on the score of expense. The practicability of adopting some form of American coupling has, however, been perfectly demonstrated, and in certain cases such a coupling has been introduced for passenger service as we have already noted in preceding pages. We may take it then that in America freight trains are practically as well under control, and as efficiently handled by means of automatic brakes and couplings, as are passenger trains. If this were not so there would be, of necessity, tremendous risk in operating the heavy train loads now so frequent.

Criticisms have been passed on the method of braking used for freight trains in America, especially by some British observers, but there seems little doubt that if the quick-acting air-brake is not yet perfected it is still infinitely superior to the English method of no brake at all. Accordingly, English railway companies are beginning to consider very seriously the question of providing some form of continuous brake for goods train working. Both the Vacuum Brake Company and the Westinghouse Company have devised special forms of their brake suitable for use in working heavy goods trains down long inclines where a continuous yet varied braking power may be required for a very long time. The Great Central Railway recently conducted a series of very exhaustive trials, with a train of large 30-ton freight cars fitted throughout with the rapid acting Vacuum brake. I may mention that these trials show that a train, running at 40 miles an hour on a falling gradient of 1 in 125, could be stopped in a distance of

260 yards from the point where the brake was first applied, and within a period of 26 seconds. In America the Westinghouse air-brake is the standard, and all freight stock being equipped with this brake can naturally be worked over any line. In England, however, there are two standard brakes, the Westinghouse and the Vacuum. Those companies which use the Vacuum brake for their passenger train working naturally tend to adopt it on their goods stock, and it seems probable that the Vacuum brake will become largely the standard in Great Britain for goods working, as owing to the large amount of foreign car mileage inevitable in this service it is of the utmost importance that one type of brake should be used throughout. Thus we find that roads like the North Eastern, on which the Westinghouse brake is the standard for passenger work, are installing the Vacuum apparatus on much of their goods stock. This is in spite of the fact that in some extensive trials which took place over the line between York and Scarborough with competitive goods trains fitted with the two types of brake, the Westinghouse seems to have had, if anything, rather the better of it.

Our picture, Figure 118, shows us a heavy coal train on the Bengal Nagpur Railway equipped with the rapid-acting Vacuum brake. This picture is interesting, not only as suggesting the gradual coming of these improved methods of train working, but also as depicting what we have already noticed in the preceding chapters, the immense growth of freight traffic in India within the last few years, and the improved types of locomotives and cars which have been called into existence to deal with it.

The principal criticism at the present time which may

Fig. 118. Automatic Brakes for Freight Trains.

Heavy Goods Train fitted with the Automatic Vacuum Brake, Bengal Nagpur Railway.

be passed on Indian railway working is the reckless multiplication of varying gauges. The Indian broad-gauge, on which the train in our picture is working, has a width between rails of 5 feet 6 inches. Other gauges in extensive use are the 3 foot 3⅜ inches, or metre gauge, the 2 foot 6 inch gauge, and the 2-foot gauge. It must be remembered that these gauges are not represented on merely little out-of-the-way lines, but frequently involve a considerable mileage.

The Bengal Nagpur Railway runs south-westward from Calcutta, Howrah, along the coast of the Bay of Bengal to Balasore, Cuttack, Vizagapatam, and Waltair, where it joins the Madras Railway. Another main line strikes off westward through Sambalpur, and Nagpur, connecting with the Great Indian Peninsula to form one of the alternative through routes between Calcutta and Bombay which I have already mentioned.

Our next pair of pictures shows us the kind of accommodation which is provided in England and America for the crews of freight trains. Figure 119 shows a brake van for the Highland Railway. It runs, like most English goods brakes, on four wheels, and is loaded with weights placed underneath the frames to increase the braked weight of the train. This van is provided with look-out wings for the guard, and also with a closed-in platform at either end, and end windows so that he can see clearly the train under his care. Most English goods brakes have no wings for the guard, this being a feature usually found only in passenger brakes. Usually, too, the platform at either end of the goods brake is open at the sides and end. All of them are fitted with a small stove in the centre compartment for the use of their occupants, especially during cold weather, and carry

spare lengths of coupling chain to be used in case of one breaking, and are also of course provided with a hand screw brake.

The main line of the Highland Railway runs practically from Perth, where, however, the company use the large joint station, northward through the Pass of Killiecrankie and over the Grampians to Inverness, and onward to Wick at the extreme north of Scotland. A branch runs from Inverness across to the West Coast of Scotland terminating at The Kyle of Lochalsh. The line is mostly single throughout, with extremely hard gradients, as might be expected, and presents one of the most beautiful railway rides to be found in Great Britain.

Figure 120 shows us a similar vehicle, called in America, however, a caboose, for the Chicago, Cincinnati & Louisville Railroad. This line runs from Cincinnati almost in a straight line due north-west to Griffith, 254 miles away, and is being completed into the city of Chicago itself over one of the Chicago terminal railroads. This caboose is eloquent of the change which has come over American freight train working. Formerly it was almost invariably an 8-wheeled car in which the crew of conductor and brakemen made their home during a trip. The cars were fitted with sleeping bunks for the men's use, and of course on long-distance journeys the men lived, slept, and ate in the car. The introduction of automatic brakes and couplings, however, is rapidly altering all this, and many recent cabooses have been built like the one in our picture on four wheels only, and altogether approximating more to the size and form of the goods brakes used on English roads. This car was built by the Barney & Smith Car Company. The length of this caboose is 23 feet over all, with a body 19 feet long.

FIG. 119. GOODS BRAKE, HIGHLAND RAILWAY.

FIG. 120. CABOOSE, CHICAGO CINCINNATI AND LOUISVILLE RAILROAD.

FIG. 121. 100-TON WRECKING CRANE, NORTHERN RAILWAY OF MEXICO.

Hitherto we have been considering railways and railway working from the point of view of the normal conditions of the line, but on the very best roads accidents will sometimes happen, and provision must be made by the officers of the road to deal promptly and efficiently with such wrecks or breakdowns when they occur. With the increasing weight of locomotives and rolling stock additional power is required to handle any vehicle which may leave the track. The old days of hand cranes are rapidly passing away, and powerful steam cranes capable of lifting up to as much as 100 tons are taking their place. America, having by far the biggest locomotives, of course presents us with the largest and most complete specimens of breakdown equipment. Figure 121 shows us a new steam crane built by the Browning Engineering Company, of Cleveland, for the Northern Railway of Mexico. This crane is carried on two 4-wheeled trucks and the under-frame consists of the usual four stout steel girders strongly braced together by end sills and intermediate members. The crane is mounted on a large casting at the centre of the platform thus afforded. The crane weighs 87 tons net, and 90 tons in working order with coal and water on board. The jib can reach, when lowered, to an extreme length of 45 feet 10 inches, measured from the rear coupler of the car. The outermost hook can be used for picking up and working at a radius of 30 feet 10 inches, while the large 75-ton hook has a working radius of 17 feet. The maximum lifting power of the crane is 100 tons, of which 75 tons will be handled by the main block at 17 feet radius, and 25 tons by the auxiliary block with double ropes at 25 feet radius. Our picture shows the clips carried at one end of the car; these are duplicated at the other end, and are intended to be secured to the rail when the crane is

lifting, in order to obviate any risk of movement in the crane vehicle itself.

Our next picture, Figure 122, shows us a complete breakdown train ready to start out on the road. This is one of the sets of wrecking equipment belonging to the North British Railway. Next to the engine is marshalled a tool van, then a travelling truck upon which the jib of the crane may be carried, then the steam crane itself, in this case a 6-wheeled vehicle; following that comes an open wagon loaded with pieces of timber of suitable length for blocking up a derailed carriage or locomotive, and lastly a van for the accommodation of the breakdown gang itself. This van is usually provided with seats running all the way round, with a stove from which hot water can be obtained, with an ambulance chest, and any other small articles which are likely to be of use. Frequently some of the railway men are trained in ambulance work and capable of rendering first aid should there be any injured. The vehicles composing the breakdown train are usually painted a distinctive colour, such as bright red. Trains of this description are always kept in a convenient place at divisional points on the railway. They generally have a siding to themselves and nothing may be put in front of them so that they are always ready to go away the instant that a locomotive backs down on to the train. In the event of an accident taking place a telegram is at once sent to the nearest point at which a breakdown train is stationed, and such telegrams take precedence over all others. It does not matter what communication may be passing over the wires, the telegraphist who has a message of this nature to send instantly interrupts with his code signal signifying "danger message" and everyone

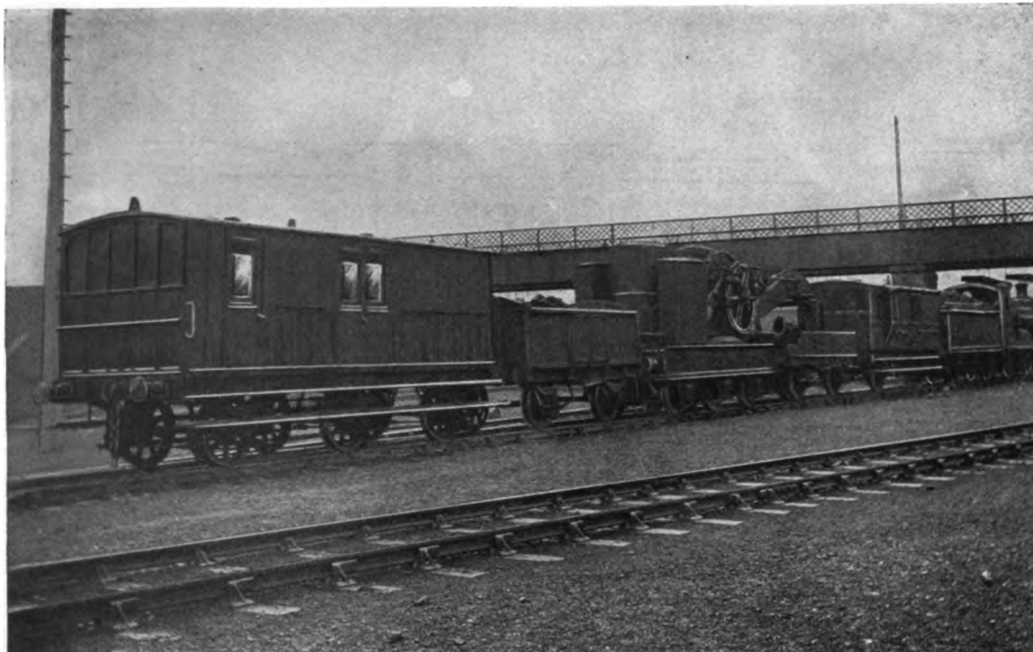

Fig. 122. A Good Samaritan. Breakdown Gang, North British Railway.

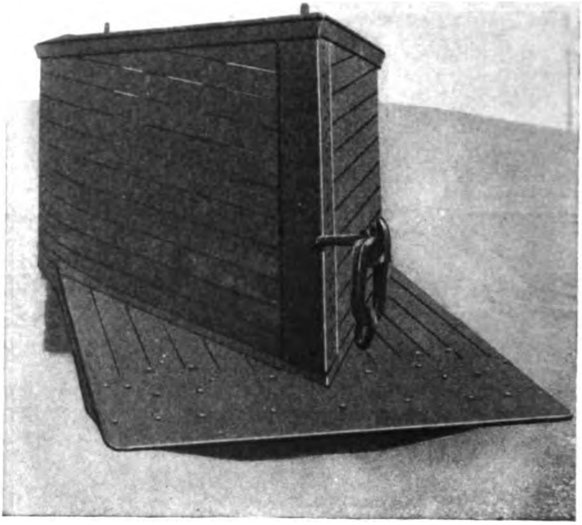

Fig. 123.

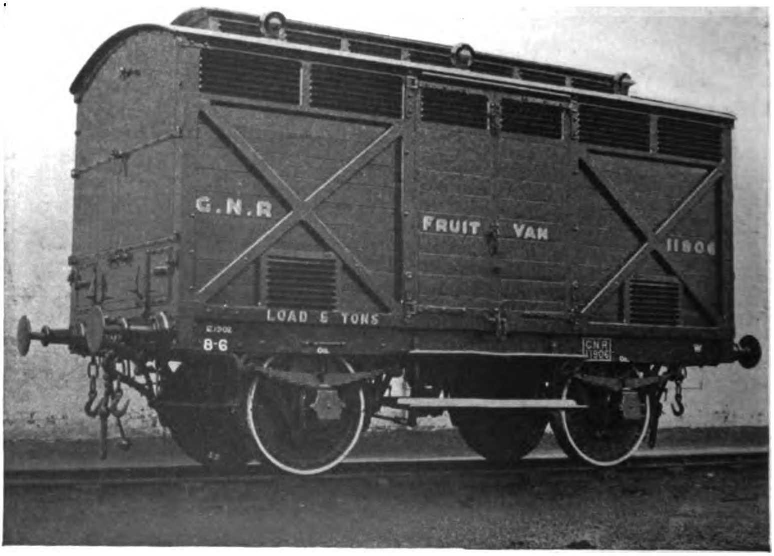

Fig. 124.

WINTER AND SUMMER.

Fig. 123. Snow-plough, North British Railway.

Fig. 124. Fruit Van, Great Northern Railway.

must at once yield the use of the line to him until his message has gone through.

In our picture the breakdown gang is seen marshalled with an express passenger engine at its head. Such trains are always worked over the road at express speed, and all other traffic, of whatever nature it is, gives way to the breakdown gang.

The tool van is one of the most interesting vehicles on this train and contains almost everything that experience has shown to be useful in dealing with the widely varying circumstances of train wrecks. Every article has its own special place in the van, and the foreman of the gang is responsible for seeing that every article is always in its place, and after the wreck is cleared up, it is his duty to see that no article, even the smallest, is left behind, while if any have been broken in use they must be promptly replaced. On many lines the tool car is fitted with a small hand crane on either side, by means of which the heavier appliances carried in the van may be lowered rapidly to the track.

Among the articles always found in the tool van are jacks of various sizes, either hydraulic or screw, used for putting underneath the vehicles or débris that has to be lifted. Small, but very strong, ramps which are used in the event of a simple derailment, and by means of which a derailed carriage or wagon may be drawn up again on to the rail. Snatch blocks, pulleys, and ropes, besides the usual varieties of saws, axes, and hammers. Arrived at the wreck, the foreman of the breakdown gang at once takes charge of the operations. His first business is to save life and to arrange for the removal and care of any passengers or railway servants who may be injured. His next business is, as soon as possible,

to get the road free for traffic again. To do this he must be a man of considerable experience, and he must know exactly how to make use of the materials he has got and the men under his command, so that no valuable minutes may be lost. He will not have been on the scene long before telegrams will begin to arrive from the district superintendent wanting to know how long it will be before the road is available for traffic again. He is never allowed to forget that the whole business of the road is waiting for him before it can be resumed over this particular section, and in the dealing with the almost infinitely varied circumstances of breakdowns and wrecks there is abundant opportunity for making mistakes which will cost the company dear in money, and the public in time and convenience, or, on the other hand, by energy and resourcefulness, for saving valuable time and rescuing precious lives.

Besides actual wrecks, the railway man has to encounter delays due to what we may call outside circumstances, such, for instance, as a heavy snowstorm. Snow, especially when drifted into cuttings, forms one of the most effective hindrances to the passage of trains that can be imagined, and accordingly most railways in the world need to be provided with some form of equipment which shall enable them to deal promptly with any snow blockade. An example of this kind of equipment is to be seen in Figure 123, which shows a small snow-plough for the North British Railway. This plough is of the push pattern, and is worked quite simply by being attached to the front end of a locomotive which then seeks to force the plough bodily through the drift. In this kind of work it is often necessary to have one or more locomotives helping behind the engine to which the plough is attached. As shown in our picture, the plough

consists essentially of a sharp cutting edge which rests upon the rails and a front shaped like a ship's prow, which shall force the masses of snow to one side. Of course in England, or even in Scotland, the snow is not usually so troublesome as it is in countries with a really severe winter climate and these comparatively primitive forms of snow-plough are sufficient to meet ordinary requirements. It may even be possible to go through the winter without having to use the plough at all, and in the event of snow coming, if the ploughs are got out promptly and kept moving over bad parts of the road it may be quite possible to prevent serious drifts from forming. Where, however, a real continental winter prevails, this kind of provision becomes no longer adequate, and so we have, for instance, powerful ploughs like the Russell snow-plough. This is a large machine with cutting edges approximated to the shape of a real plough-share, only, of course, on an immense scale. This share or cutter is mounted on an 8-wheeled car, the covered-in portion of which serves as a caboose for the men in charge. In principle, however, it is the same as the ordinary little plough mounted on the front of a locomotive, only on a larger scale. In the mountainous districts of North America these small ploughs, it may be noticed, are carried regularly on trains throughout the winter, but in very many regions where the snow fall is very great, and where there is a marked tendency shown for the snow to be drifted by reason of winter gales into the valleys, these appliances are found to be no longer adequate. Some relief is sought by building snow sheds along exposed parts of the line. These sheds consist of a lean-to roof sloping against the side of the mountain and adjusted at such an angle that snow falling down the mountain-side in an avalanche

would pass over the roof of the shed and continue its fall without blocking up the railway tracks. On all the roads crossing the Rockies this device is in more or less constant use. One of the most noted of the sheds is the famous one on the Canadian Pacific Railway, between Glacier and Illecillewaet, where the line crosses the summit of the gigantic Selkirks. Here there is an outer track used in the summer-time while the winter track under the snow sheds is available in bad weather. Sometimes a line passes through the centre of a deep valley. In such a case the lean-to type of shed is impracticable, and a shed has to be built, roughly square in form, with heavy filling behind both sides, in order to support it against the pressure of the snow. The great difficulty with these snow sheds is the danger from fire. Being built of timber they tend to get very dry in the summer months, and a spark from a passing locomotive may do a great amount of damage. A snow shed is thus a very expensive and not wholly satisfactory form of protection. Moreover, it cannot in the nature of things afford complete protection. There has thus arisen a demand for some appliance which shall enable a railroad to deal promptly with the severest kind of drifts, so as to reduce the delays they impose to a minimum.

Figure 125 shows us the kind of device which is being adopted with this end in view. It represents a snow-plough constructed upon an entirely different principle from the old-fashioned wedge-shaped push ploughs. In fact the word plough in connection with this machine is rather a misnomer. As will be seen from our picture the front of the machine consists of a large circular fan fitted with blades. This wheel is composed of 10 hollow cone-shaped scoops, the surfaces of which are perfectly smooth so as to avoid all possibility of the snow sticking

to them. Each scoop is open for its entire length on the front side through which the snow is taken in. Knives are hinged, one on each side of the opening, arranged so as to adjust themselves automatically into cutting position. The centre of this wheel consists of a stout conical boss which pushes forward into the snow while the knives behind it, as the wheel rapidly revolves, slice the snow away from the face of the drift, causing it to fall into the scoops which, as they also revolve, fling the snow which has fallen within their embrace far away to whichever side of the track the stream of flying snow may be deflected. The wheel of the rotary is encased in a drum with a square front or hood. At the bottom this hood projects only a few inches in advance of the cutting blade at the circumference of the wheel, while, at the centre of the wheel, the hood falls back so that the knives are the first to encounter the snow. The front truck of the rotary is equipped with ice cutters which travel over the rail immediately in front of the leading wheels, and flangers which follow the trailing wheels of the truck, deflecting ice from the rail and avoiding thus any risk of the rotary itself becoming derailed. It is of the utmost importance that these ice-cutters and flangers should be in perfect order, and any parts likely to give out are carried in duplicate in the housing of the machine. The ice-cutters and flangers are raised and lowered by means of steam cylinders. The rotary is driven by means of a small engine consisting of two horizontal cylinders with slide valves controlled by Walschært valve gear, while steam is supplied by a locomotive boiler with a Belpaire firebox.

The under-frame on which all this machinery and the boiler is carried consists of heavy steel longitudinal beams strongly braced together by the usual end sills and inter-

mediate members. The whole machinery is encased, as will be seen from our picture, in a large cab, which has been specially designed to secure the comfort and safety of the crew. The front compartment is the pilot house. The floor of this house is built over the engine of the plough so that the pilot may have a clear unobstructed space for the performance of his duties. The bulkhead between the pilot house and the boiler-room is immediately in front of the boiler itself. In the boiler-room is the part of the cab in which the engineer and his fireman do their work. Coupled to the rotary behind is a large tender of the usual locomotive design carrying an ample supply of coal and water. The roof of the rotary cab, however, projects aft so as to form, with the small cab on the tender, a completely protected space for the fireman in fetching coal for his fire.

The crew of the rotary consists of three men, the pilot, engineer, and fireman. The rotary is moved by an ordinary locomotive travelling behind and pushing it. One heavy consolidation engine usually provides sufficient power to move the plough. For its successful operation it is essential that not only the crew of the rotary, but also those of the pusher, should be well experienced in this class of work. The pilot is virtually in command of both pilot and locomotive, and to him running orders are usually addressed from headquarters. The pilot has under his control the small auxiliary engine for operating the flangers and ice-cutters. He signals his orders to the engineer of the rotary by means of an air whistle, and by means of the steam whistle, with which the rotary is also equipped, to the engineer of the pusher. The wheel of the rotary should always be running while the train is in motion except when going over a bridge or trestle. It is most important that the engineer on the

FIG. 125. ROTARY SNOW-PLOUGH, DENVER, NORTH-WESTERN AND PACIFIC RAILWAY.

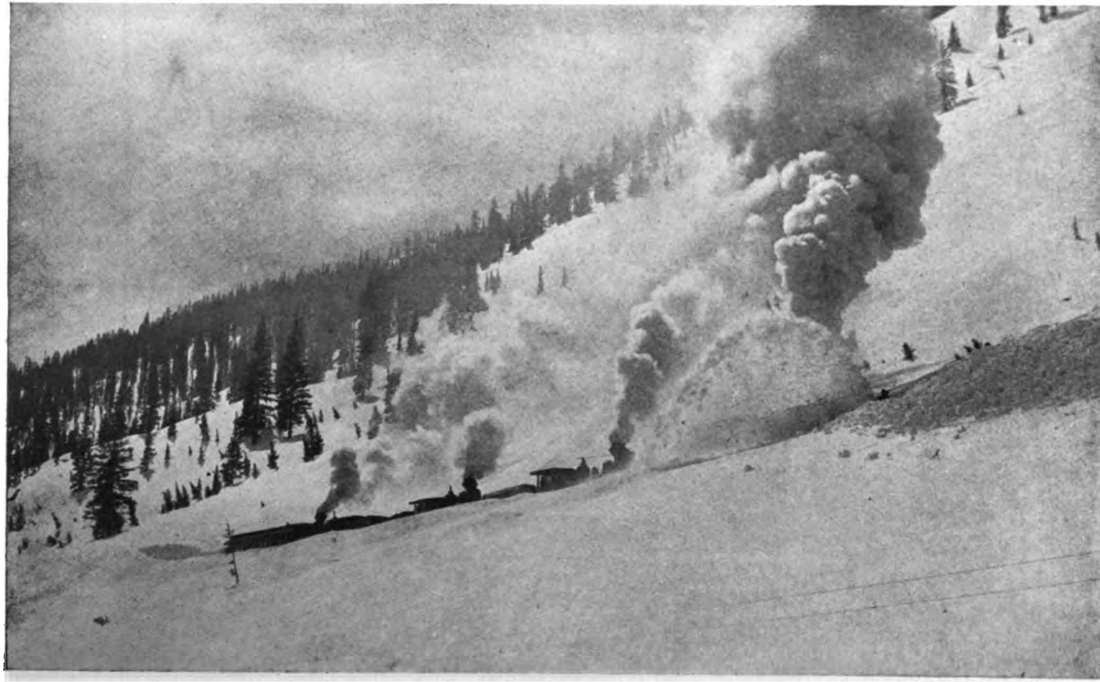

Fig. 126. A Rotary at Work in a Drift.

locomotive should not start until he receives orders from the pilot of the rotary who has of course previously started his wheel to work.

The rotary must not be driven into a bank of snow at a speed of more than 3 or 4 miles an hour, because with this type of plough it is not by main force that the drift is overcome, but by the actual removal of the snow by the wheel. Arrived near the drift which is blocking the line, the pilot signals the engineer on the rotary to go ahead. The engineer then opens his throttle or regulator, and controls the speed of the wheel with his reverse lever, so that it is running at about 150 revolutions per minute. When within about 5 feet of the bank the pilot again signals the rotary engineer who increases the speed of his wheel. As soon as the rotary strikes the snow the pilot signals to the pusher to come ahead gently. If he finds that the plough stands the force of the pusher he gives a second signal to come ahead, on which the engineer of the locomotive will give his engine all the steam it can take. If the pusher is found to be crowding the rotary too much, the pilot signals the engineer on the plough to increase the speed of the wheel. If, however, this is not sufficient, he must promptly apply the air-brakes to check the pusher. If this is not sufficient he must signal the engineer of the pusher to shut off, which signal must be obeyed promptly to avoid stalling the rotary. When nearing the end of a drift the rotary must slow down ready to be reduced to the normal speed of the wheel as soon as the plough is clear of the bank.

The rotary snow-plough is built by the American Locomotive Company, and ploughs of this description are at work, not only extensively in North America, but also on many of the European lines such as those of the Roumanian State Railway and the Hungarian State Rail-

way. The plough in our picture was built for the Denver, North-Western & Pacific Railway. This little road climbs up from Denver for 109 miles into the mountains to a place called Sulphur Spring. It is interesting to notice that the down passenger train which runs over the line three times a week is given exactly 10 hours for the run, a booked speed of a little under 11 miles an hour. This time-table is eloquent of the nature of the road, and of the country through which it passes. Our last picture, Figure 126, shows the rotary actually at work in a drift among the mountains during a recent winter.

We have now completed our survey of the work of a railroad, both as concerns its passenger and goods departments. To illustrate the general principles of railway working, I have chosen instances drawn as far as possible from every country of the world. The results of our investigation, I hope, have been such as to show us that there is no more fascinating theme which can possibly engage our interest and attention than the working of those great adjuncts to modern civilisation, whose presence is a unique event in history and the distinctive contribution of the last hundred years to the progress of the human race, and also a remarkable fulfilment of the ancient prophecy now more than 2400 years old, and uttered at the centre of one of the greatest civilisations of the world, but to-day bearing more than ever the marks of a literal and exact fulfilment that "Many shall run to and fro, and knowledge shall be increased."

THE END

INDEX

Howden
Boy's book of railways.